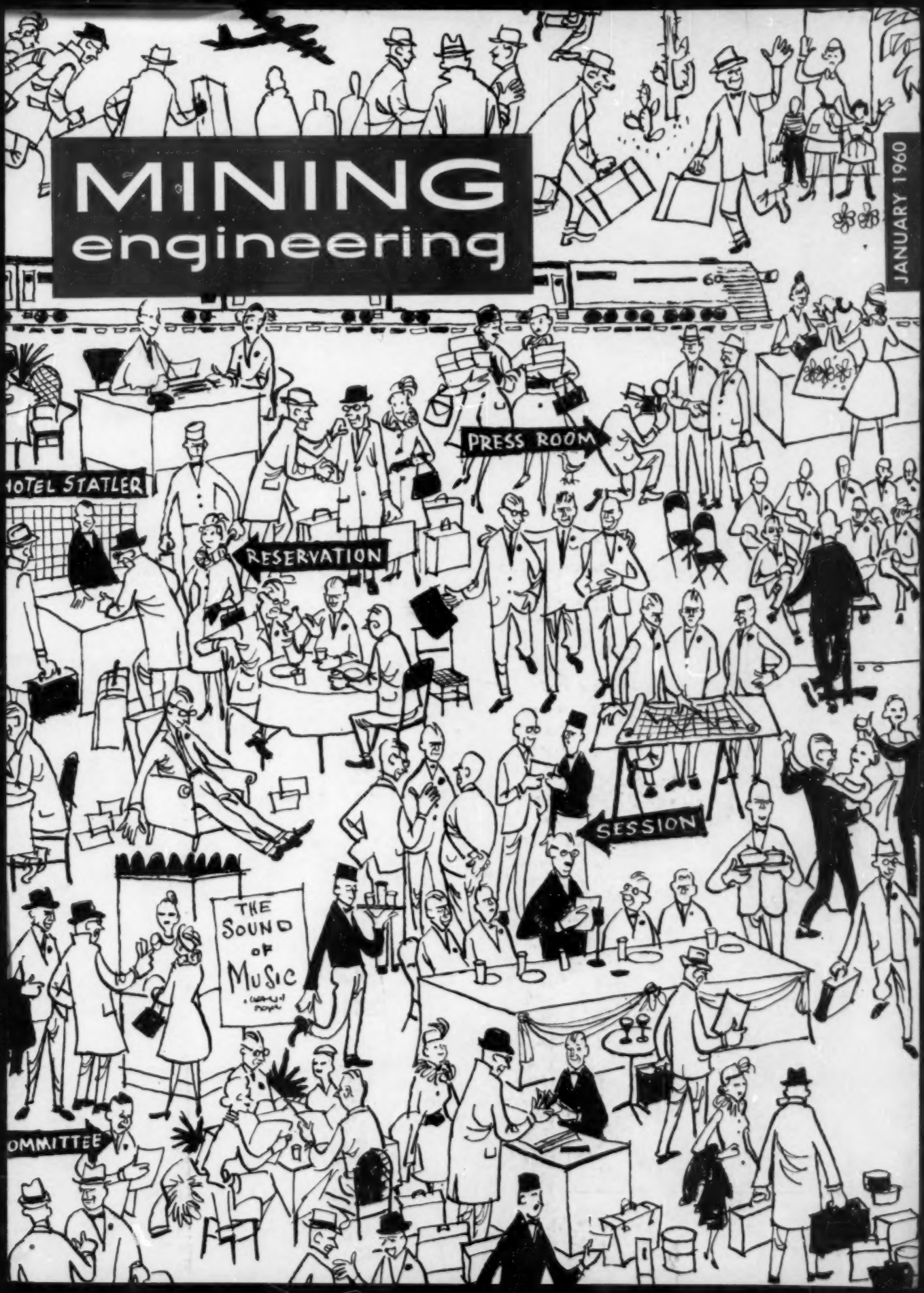
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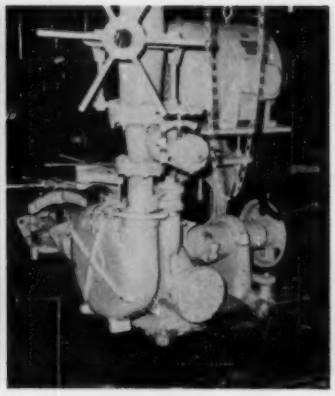

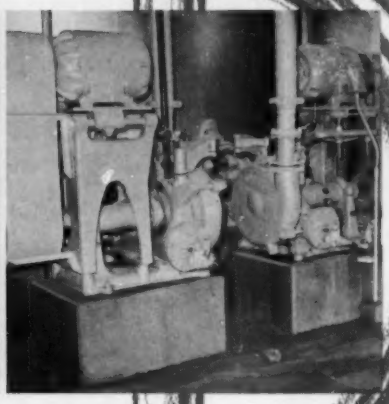

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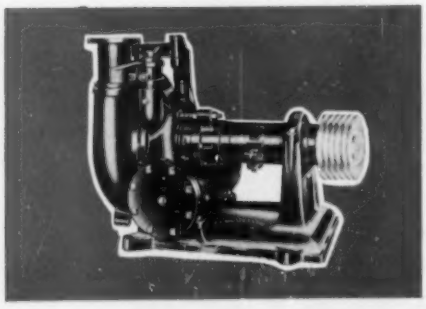

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COMING EVENTS

February, Symposium on Pilot Plants in Metallurgical Research and Development, Jamshedpur, India.

Feb. 3, AIME Chicago Section, "Ferro-Alloys Production, Uses, and Trends" by E. R. Saunders, Chicago.

Feb. 6, AIME Utah Section, Annual Miners Revue, Newhouse Hotel, Salt Lake City.

Feb. 14-18, AIME Annual Meeting, Hotels Statler and Sheraton-Atlantic, New York.

Feb. 16-17, 10th annual California Statewide meeting, Governor's Industrial Safety Conference, Fairmont Hotel, San Francisco.

Feb. 16-19, Australasian Inst. of Mining and Metallurgy, Symposium on Hydrometallurgy, "Wet Processing of Minerals and Industrial Products," Adelaide, Australia.

Mar. 2, AIME Chicago Section, "New Progress in Conventional Metal Forming Technologies" by N. H. Polakowski, Chicago.

Mar. 17-19, National Western Mining Conference, Denver Hilton Hotel, Denver.

Apr. 3-8, 1960 Nuclear Congress, sponsored by EJC, New York Coliseum, New York.

Apr. 4-6, AIME Blast Furnace, Coke Oven, and Raw Materials and National Open Hearth Steel Conferences, Palmer House, Chicago.

Apr. 4-6, AIME National Open Hearth and Blast Furnace, Coke Oven, and Raw Materials Conferences, Palmer House, Chicago.

Apr. 6-9, International Mineral Processing Congress, sponsored by The Institution of Mining and Metallurgy, Church House, Westminster, London, England.

Apr. 11-13, 5th Alaskan Mining, Minerals & Petroleum Conference, sponsored by the AIME Alaska Section and AIME Southwest Alaska Section, CIM Yukon Section, and the University of Alaska, campus, University of Alaska, College, Alaska.

Apr. 21-22, AIME Pacific Southwest Regional Metals and Minerals Conference, Ambassador Hotel, Los Angeles.

Apr. 25-27, CIM Annual Meeting, Royal York Hotel, Toronto.

Apr. 28-30, AIME Pacific Northwest Regional Conference, Sheraton Hotel, Portland, Ore.

May 9-11, American Mining Congress, Coal Convention, Pittsburgh.

May 9-13, 2nd Southwestern Metal Exposition and Congress, ASM, State Fair Park, Dallas.

May 16-20, International Conference on Strata Control, sponsored by Charbonnages de France, Paris, France

June 5-10, ASME semi-annual meeting, Statler Hilton Hotel, Dallas.

June 10-11, Wyoming Mining Assn., Jackson Lake Lodge, Wyo.

July 11-18, 2nd World Conference on Earthquake Engineering, organized by Science Council of Japan in cooperation with Japan Soc. of Civil Engineers, Architectural Inst. of Japan, Seismological Soc. of Japan; Tokyo and Kyoto, Japan.

Aug. 15-25, International Geological Congress, Copenhagen, Denmark; for information, write Mineralogical-Geological Museum, University of Copenhagen, Oster Voldgade 7, Copenhagen K, Denmark.

Oct. 5-7, AIME Rocky Mountain Minerals Conference, Utah Section host, Newhouse Hotel, Salt Lake City.

Oct. 6-8, 9th National Clay Conference, Purdue University, Lafayette, Ind.

Oct. 10-13, American Mining Congress, Mining Show (metal mining-industrial minerals convention, exposition), Convention Center, Las Vegas, Nev.

Nov. 7, AIME Pittsburgh Section, Off-the-Record Meeting, Penn-Sheraton Hotel, Pittsburgh.

Nov. 7-10, Soc. of Exploration Geophysicists, annual international meeting, Galveston, Texas.

Feb. 26-Mar. 2, 1961, AIME Annual Meeting, Chase and Park-Plaza Hotels, St. Louis.

Apr. 12-14, International Symposium on Agglomeration, sponsored by SME, SPE, and TMS of AIME, Hotel Sheraton, Philadelphia.

Sept. 17-20, Commemoration of the 50th Anniversary of Froth Flotation in the U.S.A., sponsored by AIME: Society of Mining Engineers' Mineral Beneficiation Division, Cosmopolitan Hotel, Denver.

MINING engineering

Vol. 12 NO. 1 **JANUARY 1960**

COVER *The somewhat frantic meeting scene on the cover by artist Herb McClure is particularly appropriate for this issue in which are published additional (see also December 1959) SME Annual Meeting paper abstracts and further program details—turn to page 22 for this section. Reminder:* **DON'T FORGET TO BRING YOUR SME PREPRINT COUPONS FOR THE FEBRUARY ANNUAL MEETING—COMPLETE PREPRINT AVAILABILITY LIST FOR MAIL ORDERS WILL APPEAR IN THE FEBRUARY ISSUE.**

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MINING ENGINEERING staff, Society of Mining Engineers, and AIME Officers are listed on the Drift page.

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PERSONNEL

THESE items are listings of the Engineering Societies Personnel Service Inc. This Service, which cooperates with the national societies of Chemical; Civil; Electrical; Mechanical; Mining, Metallurgical, Petroleum Engineers, is available to all engineers, members and nonmembers, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 5 pct of the first year's salary of a nonmember, or 4 pct if a member. Also, that you will agree to sign our placement fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number. When making application for a position, include 8¢ in stamps for forwarding application to the employer and for returning when possible. A weekly bulletin of engineering positions open it available at a subscription rate of $3.50 per quarter or $12 per annum for members, $4.50 per quarter or $14 per annum for nonmembers, payable in advance. Local offices of the Personnel Service are at 8 W. 40th St., **New York 18;** 57 Post St., **San Francisco;** 84 E. Randolph St., **Chicago 1.**

In addition to the listings below, ESPS maintains a more complete file of general engineering positions and men available. Contact nearest ESPS office, listed above.

MEN AVAILABLE

Manager, Superintendent, Chief Engineer, B.S. in mining engineering, age 39. Varied mining experience for 18 years, last six in top management. Energetic, good organizer in establishing new mining operations, strong in personnel, labor, and community relations, financial and cost accounting. Fluent Spanish. Available immediately; location, open. M-513.

Director of Mineral Exploration and Mining, age 51, B. S. in general engineering. Has 25 years experience in mineral exploration and open pit mining. Desires foreign work. Prefers Caribbean area. M-514.

Professorship, Mineral Engineering. To present courses and conduct research in mine and mill plant design. Rank and salary dependent on qualifications. An advanced degree in mining, metallurgical, mechanical, or electrical engineering and knowledge of mineral industry preferred. Contact **Professor E. P. Pfleider, School of Mines, University of Minnesota, Minneapolis, Minn.**

Assistant Superintendent in a well-established sulfide flotation plant located in Eastern United States. Should have a degree in metallurgical or chemical engineering, at least ten years experience in sulfide flotation research and operating, and recognized executive ability. Must be able to organize and supervise the development program for improving the process, in addition to the normal duties of an assistant plant superintendent. Submit complete record and expected salary to **Box 10-ME.**

Manager-General Superintendent, graduate mining and mechanical engineer, age 38. Varied experience for 12 years both open pit and underground. Presently manager of large, varied multi-million dollar operation. Excellent background and record. Very adaptable and capable of complete responsibility. Speaks Spanish. Prefers South, West, or Mexico. M-515.

Director of Mineral Exploration, degree in general engineering, age 51. Mineral exploration experience for 25 years; also open pit mining. Desires foreign work. $18,000. Prefers Caribbean area. Home, Oregon. S(M)-1332.

Geologist or Mine Engineer, B.S. in mining engineering, graduate work with geology, age 44. Solid academic background. Seventeen years varied experience in minerals exploration, market analyses, administration. Excellent accomplishment in finding and developing ferrous, non-ferrous, uranium, non-metallic deposits. Interested in raw materials application, business development, management. Speaks Spanish. $12,000. Prefer U. S. Home: California. S(M)-1307.

Sales Engineer, graduate mining engineer, age 45. Seven and one half years sales and production of wire rope items. Nine years supervision of design, quality control, inspection of wire rope products. Two years mining engineer on underground. $16,000. Prefer California; will consider any location. Home: California. S(M)-705.

Mining Engineer, B.S. degree in geology, age 34. Seven years experience in mining engineering and ventilation in cave-block and stope mines. Surface surveying. Engineering control for shaft raising and concreting. General underground ventilation, fan layouts, air cooler design, dust collection layouts, dust sampling. $6600 minimum. Prefer Rocky Mountains or Southwest. Home: Montana. S(M)-341.

Professor or Geologist, B.S. in mining engineering, Ph.D. in geology, age 44. One and one half years teaching and geological research for university. Twelve years chief engineer and geologist on studies, mapping, reports, exploration; also consultant on metallurgical tungsten. $12,000. Prefer San Francisco, New York, or Foreign. Home: South America. S(M)-1297.

Mine Engineer or Inspector, graduate in geology, age 35. Three and one half years experience as mine engineer, doing planning, designing, developing plant improvements, recommending machinery and equipment, cost estimates, production, geological studies and reports for phosphate mining. Five years construction inspector, estimator, doing field surveys on military facilities and underground utilities. $7200. Prefer West Coast or overseas, Southwest. Home: Florida. S(M)-1267.

Assistant Mine Superintendent, graduate in mining engineering, age 36. Three years assistant mine superintendent on underground and open pit copper mines. Four and one half years junior mining engineer to assistant mine foreman on lead, zinc, silver mines, including geologist, keeping plans up to date and general mine geology. $7200. Prefer Western U. S.; will consider any location. Home: New Mexico. S(M)-1173.

Mine Superintendent, age 48. Five years in charge of re-opening, rehabilitation of mercury, open pit placer and underground manganese mines. Eight months self-employed examining mine properties. Mining engineer and geologist for 19 years doing exploration and production. $7800. Prefer Latin America or Southwest. Home: Nevada. S(M)-1098.

URANIUM-VANADIUM MILLING POSITIONS

Mechanical, Chemical and Extractive Metallurgical Engineers and Chemists with good qualifications and 0 to 6 years of experience to work in Colorado Operations. Locations: Rifle and Uravan. Send resume and copy of college transcript to:

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Division of Union Carbide Corporation
Post Office Box 1049
Grand Junction, Colorado

Mining Engineer, graduate, age 30. Seven and one half years experience in production planning, quality control, pit design, civil, mechanical design, supervision of personnel for mining and milling. Two and one half years supervising bridge foundation investigation, field survey, design, draft for highway and sewage system and treatment plants. $7800. Prefer San Francisco Bay Area, California, Nevada. Home: Nevada. S(M)-849.

Mine Engineer, graduate, age 25. Three months operation and maintenance of crushing plant. Six months mine engineering assistant, contract measurement, sampling geological map, ventilation surveys, equipment inventories, progress for mining company. $5400. Prefer West. Home: Illinois. S(M)-836.

Geologist or Mine Engineer, graduate geological engineering, age 30. Three years mine engineer and geologist on lead, zinc, gold and copper. $6000. Prefer Western U. S. or Foreign. Home: Colorado: S(M)-736.

Mine Foreman or Geologist, degree in geology, age 31. Three and one half years mine geologist and foreman on surface and underground metal mining. $6480. Prefer West. Home: Idaho. S(M)-563.

POSITIONS OPEN

Mine Superintendent, engineering graduate, with at least five years supervisory open pit experience on large project. Knowledge of Spanish essential. Salary, $15,000 year. Location, South America. F8222.

Consulting Geologist, preferably petroleum, to consider and **Assistant Mine Superintendent,** graduate mining engineer, with substantial experience in underground mining in South America. Must speak Spanish. Salary, $6600 to $7200 year plus 2½ months salary and benefits as provided by local law. Family housing available; transportation provided for man, wife, and children to age of 12. Three years contract. Location, South America. F8177.

Instructor in Mining, to teach underground ore mining, open pit mining, coal mining, and mine examination and valuation as well as general course in mining machinery. Salary from $9000 to $15,000 depending on background and previous salary; no income tax. Excellent housing provided. Available August, 1960. Two year contract. Location, Far East. F8176.

Executive Vice President, mining engineering graduate, with administrative and at least ten years supervisory metal mining experience. Salary, $15,000 to $18,000 year, plus bonus. Location, West. W8163.

Mill Superintendent, preferably engineering graduate, with at least five years supervisory gravity concentration experience, for diamond mine. Latin American experience essential. Salary, $10,000 a year. Location, South America. F8154.

Sales Engineer, young, preferably mining graduate, to handle customers' inquiries regarding preparation of systems and proposals for sales. Salary, $6682 a year. Location, New Jersey. W8138.

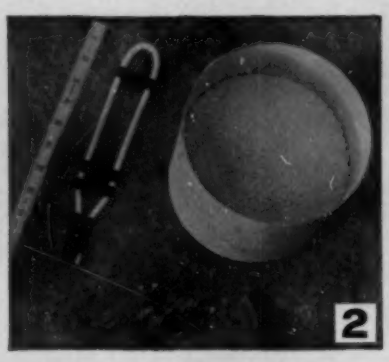
Personnel Director with at least five years supervisory personnel experience in mining and construction fields. Salary, $8000 year. Location, northern New Jersey. W8117.

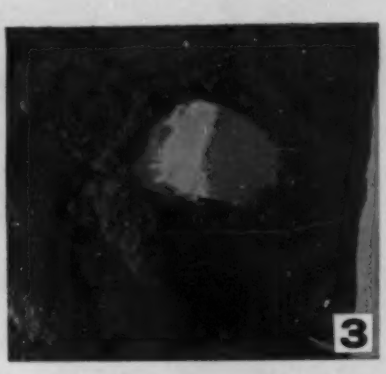
Assistant Mine Superintendent, graduate mine engineer with substantial experience in underground mining in South America and must be able to speak Spanish. Family housing, transportation for family paid (children to age 12). $6600 to $7200, plus 2½ months vacation. Three year contract. Colombia, South America. S(P)-4861.

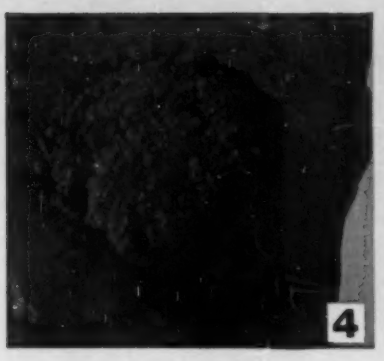
Mill Shifter, graduate, interested in ore dressing, principally responsible for metallurgical testing and control, also assist in research in upgrading and smelting problems. Salary open. Montana. S(P)-4860.

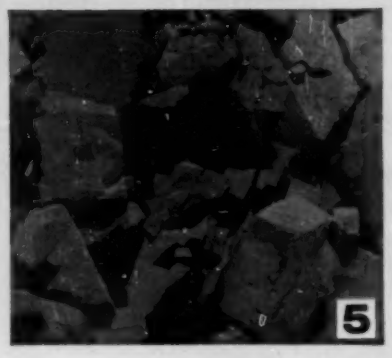
Sales Engineer, graduate mine engineer or metallurgist, age 30 to 40. Several years practical experience plus commercial experience selling or purchasing ores and minerals. Represent producing mines, supplying iron ore to Japan steel companies. Must be married and preferably with family. Salary open, plus free housing and business expense. Location, Japan. S(P)-4802-R.

Research Engineer, mining or metallurgical engineering graduate, with research and process development experience in industrial mineral fields. Salary, $6000 to $8000 yearly. Location, Southeast. W7856.









1. Basalt boulder prior to blasting.
2. Spencer N-IV and 6% diesel #2 fuel oil plus 20" of 175-grain detonating cord.
3. N-IV-fuel oil mixture being placed on boulder.
4. View of completed "mudcap."
5. Boulder after blast.

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Geophysical Surveys in Mining, Hydrological and Engineering Projects, *European Assn. of Exploration Geophysicists,* 30, Carel V. Bylandtlaan, The Hague, Netherlands, 270 pp., $4.50, 1958—This volume is devoted to case histories of mining exploration projects, water investigations, and civil engineering problems. It contains 21 papers, 13 concerned with mining problems. • • •

Symposium on Particle Size Measurement, STP 234, *American Society for Testing Materials,* 1916 Race St., Philadelphia 3, Pa., 308 pp., $6.25, 1959—This symposium includes in addition to its 18 papers a list of ASTM standards pertaining to particle size measurement. Sieves, mechanical methods of separation, electronic methods of measuring, and photo electric procedures are some of the aspects discussed. • • •

Compilation of ASTM Standards for Coal and Coke, D-5, *American Society for Testing Materials,* 1916 Race St., Philadelphia 3, Pa., 136 pp., $3, 1959—The volume covers methods of test, specifications, and definitions for coal and coke, 27 standards in their latest form. It is of particular interest to utilities, exporters and importers of solid fuels, transportation companies, and process industries. • • •

Zinc, The Science and Technology of the Metal, Its Alloys and Compounds, edited by C. H. Mathewson, *Reinhold Publishing Corp.,* over 700 pp., $19.50, 1959—This definitive monograph on the metallurgy, chemistry, extraction and uses of zinc is the most complete book ever published on the subject, with 45 specialists covering the field from geology to the end product. Written with the cooperation of the American Zinc Inst., the fourteen chapters cover economics, ore treatment, refining, processing, the biological significance of zinc and many more related aspects. • • •

Chemical Industry Facts Book, fourth edition, *Manufacturing Chemists' Assn., Inc.,* 1825 Connecticut Ave., N. W., Washington 9, D. C., $1.25, 1959—Designed as an aid to economists, journalists, students, teachers, and others requiring specific information on the chemical industry and its products, the illustrated book contains material on virtually every aspect of the field.

1958 Symposium on Bulk Sampling, STP 242, *American Society for Testing Materials,* 1916 Race St., Philadelphia 3, Pa., 64 pp., $2.25, 1959—This symposium sponsored by ASTM Committee E-11 of quality control at the Society's 61st annual meeting presents some current thinking on the problem, with the hope that it will serve as a guide and stimulant for future work in this field. • • •

Bibliography of Theses in Geology and Related Sciences, by John and Halka Chronic, *Pruett Press,* Boulder, Colo., 424 pp., $15, 1959—This reference book lists 11,091 theses written for advanced degrees at universities in the U. S. and Canada, including author, degree, date, university, and complete title. • • •

Journal of Research of the National Bureau of Standards, *Superintendent of Documents,* U. S. Government Printing Office, Washington 25, D. C., in four sections: **A—Physics and Chemistry,** $4; **B—Mathematics and Mathematical Physics,** $2.25; **C—Engineering and Instrumentation,** $2.25; **D—Radio Propagation,** $4. These comprehensive scientific papers give complete details of the work, including laboratory data, experimental procedures, and theoretical and mathematical analyses.

Our Mineral Resources, by Charles M. Riley, *John Wiley & Sons, Inc.,* 348 pp., $6.95, 1959—This book is unique in that it offers an elementary approach to a subject most often taught at a college senior or graduate level. With a minimum use of scientific terminology, it presents a great amount of scientific theory and useful fact. • • •

The Northern Rhodesia Chamber of Mines Year Book for 1957 and 1958 are only available from The Northern Rhodesia Chamber of Mines, P. O. Box 134, Kitwe, Northern Rhodesia. Copies of the 1956 yearbook only are also available from American Metal Climax Co., 61 Broadway, New York 6, N. Y., American Metal Climax is anxious to distribute their supply of the 1956 volume.

The Chemical Elements, by Helen Miles Davis, *Science Service,* 1719 N. St., N. W., Washington 6, D. C., 204 pp., 55¢, paperback, 1959—This is an authoritative story of the discovery of the building blocks of the physical universe, from H for hydrogen to the latest discoveries of the atomic era, 93 to 102. Each element, its properties, sources, varieties, characteristic compounds, and place in periodic tables is clearly discussed.

World Directory of Mineral Industries Education, edited by Howard L. Hartman, published by the *Council of Education, AIME,* Room 206, Mineral Science Building, The Pennsylvania State University, University Park, Pa., 88 pp., paperbound, 25¢, 1959—Thorough list of universities offering mineral industries education.

Brimstone, The Stone That Burns, by Williams Haynes, *D. Van Nostrand Co. Inc.,* 120 Alexander St., Princeton, N. J., 308 pp., $5.95, 1959—The story of the American sulphur industry is related from the earliest pioneering days in the Louisiana swamps, through the years of struggle and competition in America and abroad, and up to today's new sulfur recovery developments in France and Canada. • • •

Extractive Metallurgy, by Joseph Newton, *John Wiley & Sons, Inc.,* 540 pp., $9.75, 1959—This book is essentially a revision and enlargement of the second part of *Introduction to Metallurgy,* second edition, by the same author. In addition to the subjects conventionally covered in extractive metallurgy, there is included some discussion of metal crystals, equilibrium diagrams, and Gibbs' phase rule. • • •

STATE PUBLICATIONS

Arizona

Arizona Bureau of Mines
University of Arizona
Tucson, Ariz.

Petrology, by G. M. Butler, 50¢, 1959.
Cochise County Geologic Map, 75¢, 1959.

California

Dept. of Water Resources
Sacramento, Calif.

State Water Right Applications for Unappropriated Water, $3.12, 1959.
Water Today and Tomorrow, gratis, 1959.
Methods of Analysis, supplement to report on 1956 cooperative study program: Water Use and Water Rights along Sacramento River, $1.56, 1959.

Div. of Mines, Ferry Bldg., San Francisco
Franciscan Chert in Californian Concrete Aggregates, Special Report 55, 50¢.

Colorado

Inspector of Coal Mines
Colorado Bureau of Mines
220 Museum Bldg.,
14th and Sherman
Denver, Colo.

Combined Annual Reports, 1944-1945-1946, gratis.

Colorado School of Mines
Golden, Colo.

Refractory Materials, Mineral Industries Bulletin v. 2, no. 2, first copy gratis, additional copies 50¢ each, 1959.
Proceedings of the Third Annual Rock Mechanics Symposium, $3, 1959.

ABSTRACTS

In This Issue: *The following abstracts of papers in this issue are reproduced for the convenience of members who wish to maintain a reference card file and for the use of librarians and abstracting services. At the end of each abstract is given the proper permanent reference to the paper for bibliography purposes.*

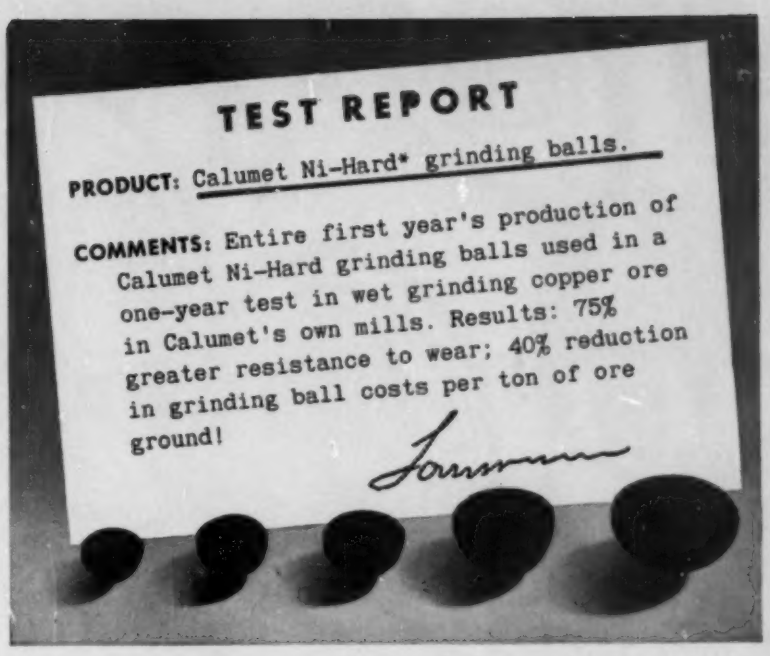
Explosions Research Applied to Mine and Quarry Blasting by *Clifton W. Livingston*—The shock wave reflection theory of blasting grew out of research conducted as a result of atomic explosions—a knowledge of how rock fails when subjected to impact or explosion was required. A breakage process equation was evolved. Six phases are necessary to the successful application of the calculations. **Ref.: MINING ENGINEERING, January 1960, p. 29.**

Kaiser Industries Corp.: Principles of Management by *Henry J. Kaiser, Jr.*—The article is an expansion of ideas expressed by Mr. Kaiser during the AIME Annual Meeting in San Francisco, February 1959. The ten key points on which Kaiser management philosophy is centered are: vertical-horizonal structure delegation of responsibility, open-door consultation, teamwork, individual freedom, challenge, management development, communications, incentive, and accomplishment. **Ref. MINING ENGINEERING, January 1960, p. 31.**

The Future of the Mineral Industries edited by *W. C. Lacy*—Students and young engineers not yet established in the mineral industry face the problem: "What is the future of the mineral industries, and what type of training will best qualify the scientist or engineer for this challenging field?" This question was posed to a number of leaders in different phases of the industry. Their answers comprise the bulk of the article. **Ref.: MINING ENGINEERING, January 1960, p. 34.**

Current Trend of Production and Consumption of Sources of Energy by *Eugene Ayres*—The study is concerned primarily with a backward look at the projections made in the *Report to the President by the President's Materials Policy Commission* issued in June 1952. Major sources and forms of energy are considered from the standpoints of ultimately available amounts and rates of production and demand. Sources dis-

(Continued on page 8)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MANUFACTURERS NEWS

NEWS / EQUIPMENT / CATALOGS

High Capacity Drill

The Presidenté is *Acker Drill Co's.* big new rig for high capacity core drill work. While fully tried and field tested, the Presidenté incorporates a fresh design approach according to the company. Built for heavy duty the machine will work to depths of 4500 ft as a core drill or to depths of about 1500 ft as a rotary. All controls are grouped for operator convenience, an automatic chuck (extra cost option) speeds up rod handling, and two separate speed ranges are built into the hydraulic drill head. Optional usages outlined are to safely core to 4500 ft with AX bits, to 3000 ft with NX, or for 6-in. water well drilling to 1500 ft. The skid mounted model will winch itself into position under its own power. Truck mounted units also are available and due to unitized design any power source can be used. **Circle No. 1.**

Rotary Portable Compressor

Gardner-Denver Co. has introduced a new design of its 125 cfm rotary portable air compressor to utilize the latest engineering developments. The changed design increases horsepower capacity 15 pct for more fuel economy and a special control automatically regulates engine speed to meet air demand for more economical operation and greater engine life. An automatic water circulating system insures that compressor and engine operate at constant temperature despite temperature changes. **Circle No. 2.**

Formula Capsule

Eliminating manual errors in blending, proportioning, and batching operations by taking formulation out of the hands of the operator and automatically setting proportions of chemicals, etc., is function of compact, simple formula capsule or electronic brain introduced by *Richardson Scale Co.* **Circle No. 3.**

Low-Head Picking Table

Development of a new shortstroke, horizontal picking table for hand removal of refuse from scalped run-of-mine coal and other products had been announced by *Allis-Chalmers.* The Low-Head table which can also be used as a conveyor or feeder, is available in 3, 4, 5, or 6-ft widths and in lengths up to 20 ft. **Circle No. 4.**

Better Blasting

Greater safety and economy in coal mining are the advantages of multiple firing of explosive charges with Coal King delay electric blasting caps according to *American Cyanamid.* In multiple blasting the Coal King cap detonates complete rounds of permissible explosives without requiring the shotfirer to return to the face between blasts as is the case with single shot firing. **Circle No. 5.**

Vacuum Blowers

Ten sizes of small-volume vacuum blowers comprise the line now being offered by *Roots-Connersville,* (Div. of Dresser Industries Inc.) Designed for capacities from 30 to 1000 cfm and vacuum to 20-in. Hg. for single stage application these units may be compounded for higher vacuum service. Major features of design as listed by the manufacturer include elimination of internal valves, no contact between moving parts, and minimum sealing water requirements. **Circle No. 6.**

Rotary Bits

Varel Mfg. Co. has developed a new formation type rock bit to meet the immediate needs of blast hole drilling in mining and quarrying operation where fast penetration rates are necessary, but where excessive gage wear has been a problem. **Circle No. 7.**

Portable Conveyor

Farfield Eng. Co. announced a new high capacity conveyor for use in coal mines or to handle other nonabrasive materials. Designed primarily to work with auger drills in coal mining, the 210-tph capacity will handle output of largest augers in use today. Discharge heights vary from 10 to 17 ft, and flight speed is 120 fpm. **Circle No. 8.**

Magnet Pulleys

A complete line of Indox V permanent magnet pulleys in diameters up to 48-in. is now being offered for heavy duty tramp iron removal and cobbing by *Stearns Magnetic Products.* Through previous experience in the 12 to 24-in sizes Stearns has been able to extend its applications to the larger sizes. Indox V, a highly oriented barium ferrite ceramic material, is said to provide pulley performance equal to the most powerful electromagnetic types and at lower cost, according to Stearns. **Circle No. 9.**

Portable Shelters

Development of portable sheds to protect outdoor workers on the ground has been announced by *Luria Eng. Co.,* manufacturers of preengineered buildings and other structures. The shelters cover an area of 1600 sq ft each, are designed to withstand winds to 40 mph without being anchored, and are built of braced steel frame with galvanized steel siding and roofing. Corrugated plastic sheets have been let into the roof to provide light. The sheds can be stacked on top of one another to conserve space when not being used. **Circle No. 10.**

Abrasion Protection

An abrasion-resistant adhesive rubber sheeting for do-it-yourself covering of chutes, and launders, or patching of conveyor belt surfaces has been released by *B. F. Goodrich Industrial Products Co.* Known as Armorline, the material can be applied to metal, concrete, wood and other materials almost as easily as a cold patch to an old type inner tube. Neither expensive tools nor special skill are required for covering or patching in the field. **Circle No. 11.**

Air Hoist

The JCP-120 air powered hoist from *Joy Mfg. Co.* offers a choice of several throttle and brake systems that make it adaptable for such divergent uses as in mine shafts for hoisting, for car spotting, and for barge spotting at docks. A five cylinder radial air motor of 10, 17, or 23 hp with integral gear case drives the large rope drum through multiple roller chain. The rope drum has a capacity of 2300 ft of ¾-in. wire rope. Unit is on skid base for portability. **Circle No. 12.**

Ventilating Flow Meter

Epic Inc. has a new line of Davis ventilation flow instruments for measuring air velocity in mine airways. Several models are available covering ranges from as low as 30 fpm up to as much as 6000 fpm. The instrument is light, and extension handles up to 5 ft are available as accessories. **Circle No. 13.**

Pea Shooter

A new "pea shooter" car designed and produced by *Mayo Tunnel and Mine Epuipment* injects pea gravel into the tail void formed by advancing a tunnel shield. First used in the Second Boston Harbor Tunnel, the car finds use in special tunnel jobs, under pressure, and car is dimensioned to pass lock doors. At the conclusion of a shove the car is backed outside the tunnel and reloaded. **Circle No. 14.**

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ABSTRACTS

Continued from page 5

cussed are electricity, oil, and natural gas. **Ref.: MINING ENGINEERING, January 1960, p. 38.**

Thickening Leach Residues in Sherritt Gordon's Nickel Refinery by *D. J. I. Evans and S. C. Lindsay* (TP59B37)—Solutions are presented to early difficulties in thickening ammonia leach residues at the Sherritt Gordon nickel refinery. Although countercurrent decantation was not incorporated in the refinery flowsheet, the results of the thickening studies reported, and the experience gained, are pertinent to CCD, particularly where it is to be applied to slow-settling slurries from a hydrometallurgical leaching operation. **Ref.: (MINING ENGINEERING, January 1960) AIME Trans., 1960, vol. 217, p. 41.**

Characteristics of Coal Preparation Plant Slurries by *H. B. Charmbury and D. R. Mitchell* (TP 59B86)—Coal losses from a preparation plant occur in the solid refuse material being discharged from the plant and in the bleed-off slurry from the water circuit. Results are given of studies made of samplings from slurries in eight bituminous coal preparation plants in central and western Pennsylvania. An evaluation of the results showed the economic loss to be considered and a recommendation is made that further research be conducted on new, more efficient, and more economical methods of recovering coal from the slurries. **Ref.: (MINING ENGINEERING, January 1960), AIME Trans., 1960, vol. 217, p. 49.**

SME Meeting Papers: *The following abstracts of papers presented at SME meetings are given for your information. Copies of these papers are available* **only if followed by a preprint order number.** *These preprints are obtained on a coupon basis. The coupon books may be purchased from SME headquarters for $5.00 a book (10 coupons) for members of AIME or $10.00 a book for nonmembers. Each coupon, properly filled out, entitles the purchaser to one preprint. Mail completed coupons to Preprints, Society of Mining Engineers, 29 W. 39th St., New York 18, N. Y.*

D. C. Voltage and Productivity on Operating Sections by *Guy Baker and E. H. Roberts*—Coal companies are continually faced with the necessity of maintaining a competitive position in the power field. One of the important cost areas frequently neglected is that of providing adequate voltage for machinery at the working face. The authors present the results of an intensive study made at their company, recommendations made, and improvements installed. The study system (being continued) has been altered and improved. *Joint Meeting of the AIME Central Appalachian Section and W. Va. Coal Mining Inst., White Sulphur Springs, W. Va., October 1959.*

The Effect of Chelation Agents on Electrode Phenomena by *Robert N. O'Brien*—A series of experiments has been carried out using interferometry as the analysis tool on concentration gradients around working electrodes. The apparatus used is an electrodeposition cell arranged so that it is also an interferometer. Both Fizeau-type interference fringes and multiple beam fringes have been used, the present work being entirely Fizeau fringes. The volume of electrolyte used and the electrode areas were very small. The electrodes were used in a vertical position and were two millimeters or less deep. The object of having such limited depth of solution was to prevent connection or any process other than diffusion so that changes of concentration with distance from the electrode would be stable and measurable. This work concerns the use of chelation agents added to the solution. Ethylenediaminetetracetic acid, glycine and propylene diamine were added for the reason that they gave a charge of —2, 0 and +2 respectively on the chelated cupric ion. Also the pKa's are about the same. The differences in fringe modulations between plain cupric sulphate and the chelated solutions are compared, and the chelated solutions are compared amongst themselves. Some explanations are offered for anomalous modifications. *Joint Meeting, SME, MBD-American Chemical Society, Div. of Colloid Chemistry, Atlantic City, N. J., September 1959.*

(21) REDUCTION UNITS: Two Stokes size-reduction units, the new Tornado mill and the oscillating granulator are described in 4-page bulletin 350 issued by *F. J. Stokes Corp.* The Tornado mill is a whirling-blade vertical-flow granulator with 360-degree screen. Model 43-B oscillating granulator is used in the processing of extremely friable and other problem materials.

(22) HAULAGE MACHINES: Book 2892 contains 14 typical layouts that illustrate the applications to which car spotters and car pullers can be adapted. Most commonly used for moving railroad cars, these machines are also successfully employed in handling a wide range of mobile loads. The complete line of *Link-Belt Co.* car spotters is described in this new 22-page book.

(23) RECORDERS: Complete specifications for selection of *General Electric Co.* recorders are included in bulletin GEA-6933. Buying information including dimensions and chart speeds, operating specifications, applications, features and accessories, are covered in 12 2-color pages.

(24) WINCHES: Hand and power winches, both Spur gear and Worm gear models, are listed in a new catalog from *Thern Machine Co.* Exceptionally strong, low priced, high quality, neat and attractive appearance are a few of the special features of these winches.

(25) COAL HANDLING: *Link-Belt Co.* has reprinted its profusely illustrated 16-page booklet A-2029 called "Methods of Handling Coal at Today's Power Plants," by Frank W. Lovett. Mr. Lovett describes the increased importance of coal handling equipment in relation to overall power plant design, and methods of handling coal at steam generating plants, including barge and railroad car unloading facilities, storage and reclaim, and dust control.

FREE LITERATURE

(26) FATTY ACIDS: A new basic technical booklet on fatty acids from crude tall oil is now available from *Hercules Powder Co.* The booklet discusses supply factors, describes the properties, and tells how Hercules Pamak fatty acids may be used in protective coatings, core oils, flotation, plasticizers, disinfectants, cleaners, etc. Sections are included on the origin of Pamak fatty acids, and a 2-page chart depicts industry-wide crude tall oil production and consumption from 1958.

(27) HOSE: A practical guide for hydraulic hose users has just been issued by *Hydraulics Inc.* The 16-page catalog outlines low to high pressure hose specifications. Detailed thread and fitting information is included for both the permanent and re-usable type of couplings. Their newest service, Hydra-Flex hydraulic hose assemblies, is also covered.

(28) CRANE: A new 8-page, 2-color bulletin describes the 18-ton Lorain Moto-Crane model MC-218 from *The Thew Shovel Co.* It includes 6 x 4 carrier with 2 position turntable mounting, hydraulic power steering, power brakes, and integrally welded outrigger boxes.

(29) SCALE: A fully automatic scale that weighs, discharges and records dusty, powdered, small-size granular materials, with no operating cost, is described in product data sheet offered by the *Richardson Scale Co.* Designated HHH-3, this scale processes loads from 200 lb to 600 lb per discharge, providing extremely high weighing accuracy and operating rate. In addition the data sheet lists specifications and optional accessories as well as scale drawing.

(30) FEEDER: The Omega Hi-Weight belt gravimetric feeder, a proven medium to high capacity feeder for continuously weighing and feeding dry materials at high rates, is the subject of a new bulletin released by *B-I-F Industries Inc.* Model 37-20 combines accuracy with durability, resulting in a feeder ideally suited to continuous high capacity feeding and weighing. The 4-page, 2-color bulletin 35.20-2 contains photographs illustrating the patented Sens-A-Gram mechanical controller.

(31) ROPE THREAD: Full data on Sandvik Coromant 1½-in. extension drill steel equipment are provided in a leaflet (E-431) from *Atlas Copco Eastern* and *Atlas Copco Pacific.* Hard wearing rope thread is easy to take apart and put together.

(32) CORROSION INHIBITOR: An inhibitor that displaces and seals out water and moisture, protects metal surfaces against corrosion, and lubricates is the subject of 6-page illustrated folder released by *Corrosion Reaction Consultants.* Called CRC 2-26, this liquid formula has maintenance use in the electrical and electronic equipment fields to improve characteristics and performance. Benefits, advantages and applications, factual case histories and physical details are included.

GEOCHEMICAL NEWSLETTER: We have just seen a copy of this data filled and unique newsletter issued by *Sargent Geochemical,* 829 East 4th St., Casper, Wyo.; and suggest that if you are interested in specialized analysis, of uranium and other materials, you write direct to the firm on your letterhead requesting future copies.

(33) BETTER WEIGHING: A pneumatically operated belt weigher for continuous checking of dry mater-

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61	62	63	64						

Students should write direct to manufacturer.

ials at low to medium rates is subject of bulletin 36.20-1 by the Omega Div., *B-I-F Industries Inc.* Capacity of unit is 0 to 3000 lb per hr and a sensing device adapts the feeder to recording, packing and controlling other operations.

(34) REAR DUMP: *Easton* bulletin 2-A8 describes the 35-ton capacity TS-2635 rear dump variable wheel base trailer, balanced to work in combination with Euclid's model 30 single axle tractor.

(35) IDLERS: "Conveyor Idlers of the Future" is the title of a new broadside from *Barber-Greene Co.* illustrating 14 different types of idlers specifically designed to meet problems, cut handling costs on any job.

(36) ORGANIC CHEMICALS: A catalog of *Armour Industrial Chemical Co.* aliphatic organic chemicals has just been released. The 10-page publication lists specification and chemical composition of Armour long and short chain saturated fatty acids, oleic, and unsaturated fatty acids. Typical applications for each product are also given. In addition the chemical and physical properties of over 150 fatty acid derivatives are listed.

(37) FORK LIFTS: Be years ahead is theme of *Allis-Chalmers* 16-page review of its FT series for lift trucks in bulletin BU-451A.

(38) COBRA DRILL: An illustrated folder (E-1155) showing many of the applications to which its lightweight Cobra motor drill and breaker is being put by contractors, utility companies, mining crews, and maintenance departments has been published by *Atlas Copco.* Technical features of the 53-lb, gasoline powered unit are illustrated by a cutaway drawing. Photos show the drill in action.

(39) TRACKS & TURNS: A four-page folder no. 705, offering data for mining and industrial plant engineers on various turnouts and curves off the main track, is now available from *Bethlehem Steel Co.* Table with an accompanying diagram shows point to point distances, and point to tangency spacing for cross-cuts at 20° to 90° angles.

(40) DIAMOND DRILL BITS: Detailed information, including specifications, assembly data, and prices on Asco diamond drill bits is presented in a new illustrated catalog from *Anton Smit & Co.* In addition to illustrations and descriptions of the company line of coring and non-coring bits, casing bits and shoes, reaming shells, blasthole and pilot bits, catalog no. 502 contains ordering information and brief description of manufacturing methods and standards.

(41) PROTECTION: If you have a difficult or complex problem of shielding against corrosives, radioactive corrosives, or even radiation itself, "The Insmetals Story" will be of interest. A new 16-page brochure from *Knapp Mills Inc.* tells the details of application of a series of multi-layer metals combining lead with various other resistant metals for combination protection against almost any corrosive or radioactive attack.

(42) SCRUBBER: *Western Precipitation Corp.* has released a brochure on the Tubulaire Doyle scrubber. Cited advantages include efficiency, versatility, compactness, and economy. Applications cover most industries including chemical, metallurgical, rock products, and waste disposal. Jet action scrubbing is the claimed key to high efficiency and small size.

(43) CRAWLER TRACTOR: The TD-9 from *International Harvester Co.* is subject of a 16-page catalog. The features of this 55-hp (drawbar rating) machine are outlined in photostory form.

(44) FOUR-WHEELER: A versatile four-wheel drive, four-wheel steering tractor, the Crab is covered in a brochure from *Napco Industries.* Some of the features covered include, power steering torque convert, hydraulic reversing clutch, planetary axles, and four wheel hydraulic brakes. The varied attachments are also described.

(45) CRUSHING PLANTS: Portable primary crushing plants are the topic of bulletin PP-1 from the *Iowa Mfg. Co.* Built under the Cedarapids trade name, the components of the plants such as crushers, vibrating grizzlies, and screens, are also detailed in specification sheet style with full dimension drawings. Brochure points out the advantages in cost and flexibility of adding a tertiary crushing stage to your present rock or gravel plant.

(46) MACHINERY FOR MINES: Mechanize to economize is the theme of a brochure from *Machinery Center Inc.* Highly effective and specialized units ranging from Betsy, the small incline Cryderman shaft mucker, to the Lance timbering cage are shown in photos and sketches. The train car loader is another and most interesting one of these machines built to cut mining costs.

(47) SCREEN PLANTS: An eight-page bulletin, no. 690, on its line of hydro-screen washing plants has been released by *Pioneer Engineering* (Div. of Poor & Co.) A drawing of the basic hydro-screen plant is supplemented by drawings of several different models of the plants as designed to meet specific aggregates washing problems. Specification, plus complete, detailed information on the entire hydro-screen line is included.

(48) SCRAPER & CABLEWAY: A 16-page brochure from *Sauerman Bros. Inc.* covers the handling of ores, sand and gravel, chemicals, and other bulk materials by Sauerman machines. A brief history of the company is given in the introductory pages. Four pictorial sections show DragScraper and Cableway applications.

(49) KENNEDY PRODUCTS: Bulletin 59-E from *Kennedy Van Saun Mfg. & Engr. Corp.* outlines their complete line of products for rock and ore processing, rotary kilns and accessories, specialized systems, and their engineering services.

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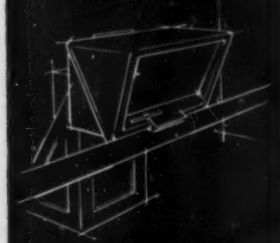

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Celle, West Germany	Celle 3452
Piacenza, Italy	20-97
Mexico City, Mexico	46-01-56
Maracaibo, Venezuela	2109
Salvador, Bahia, Brazil	1116
Calgary, Alberta, Canada	AM 9-6141
Buenos Aires, Argentina	45-4944

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Aluminum Developments

The first primary aluminum plant in Mexico will result from the efforts of a Mexican bank, Aluminum Company of America, and a group of European investors. The plant, to be situated in the state of Veracruz and served by ocean-going barges, is scheduled to be producing in two years. Output is slated at about 20,000 long tons annually. Ownership of a new company, Aluminio, S. A., which has been formed to operate the enterprise, will be as follows: Alcoa, 35 pct; European investors, 10 pct; and Intercontinental, S. A., a Mexican investment bank and other Mexican investors, 55 pct. The plant will cost almost $20 million. . . . Improved business has encouraged Aluminium Ltd. to start increasing its annual output by 6.1 pct, or 34,500 tons.

Humboldt, Cleveland-Cliffs to Expand Output

Mining and milling operations of Humboldt Mining Co. near Ishpeming, Mich., will be doubled by mid-1960, according to recent plans. The company is installing two parallel grate-kiln systems with combined capacity of 2200 tpd and will have to double its hematite output to meet the new mill demand. . . . Cleveland-Cliffs Iron Co. is scheduling an upstep in yearly output from nine million gross tons of iron ore to 16 million tons. A spokesman indicated the intention is to keep in step with the expected rise in domestic steel ingot production.

Zinc Unit on Line Again

Bunker Hill Mining Co., Kellogg, Idaho, has now reactivated all units of its five-unit electrolytic zinc plant, boosting annual output from about 60,000 to 74,000 tons. Another unit being constructed would bring total capacity of the plant to about 90,000 tons.

Anaconda Buys Butte Property

All of Butte Copper & Zinc Co.'s Montana mining properties, which it operated jointly with Anaconda Co., have been sold to Anaconda for $1,325,000. The transaction is part of a plan transferring Butte Copper assets to Jonathan Logan, Inc., a maker of women's dresses. Butte Copper owners will get shares of the dressmaker in return for company assets, including the cash deal with Anaconda.

Tsumeb to Build Smelter

The first copper smelter in South West Africa will be constructed by Tsumeb Corp. Ltd., beginning in a few months. Production is expected by 1962. The projected design will permit smelting of ores from other mines in Tsumeb's territory. The possibility of adding a lead smelting facility is being studied.

New Shaft-Sinking Record

African gold miner Vaal Reefs Exploration & Mining Co. Ltd. has broken the Russian-held shaft-sinking record with a phenomenal 922 ft in 30 days. Operating on the Far West Rand, the company sank its 26-ft diam hole during the second month of work on the No. 2 shaft. The former record, held by Russia, was for 868 ft on a 21.65-ft diam shaft in the Don coalfields.

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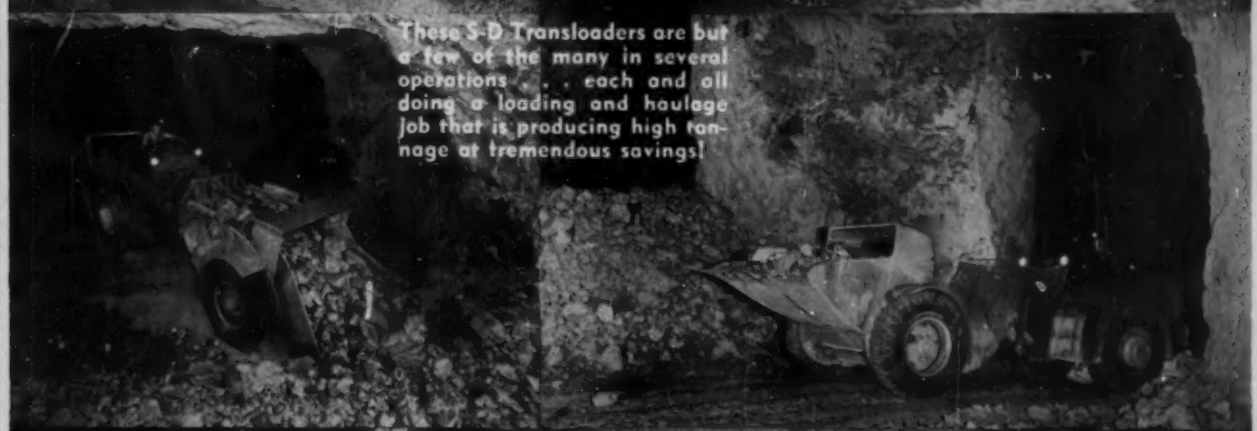

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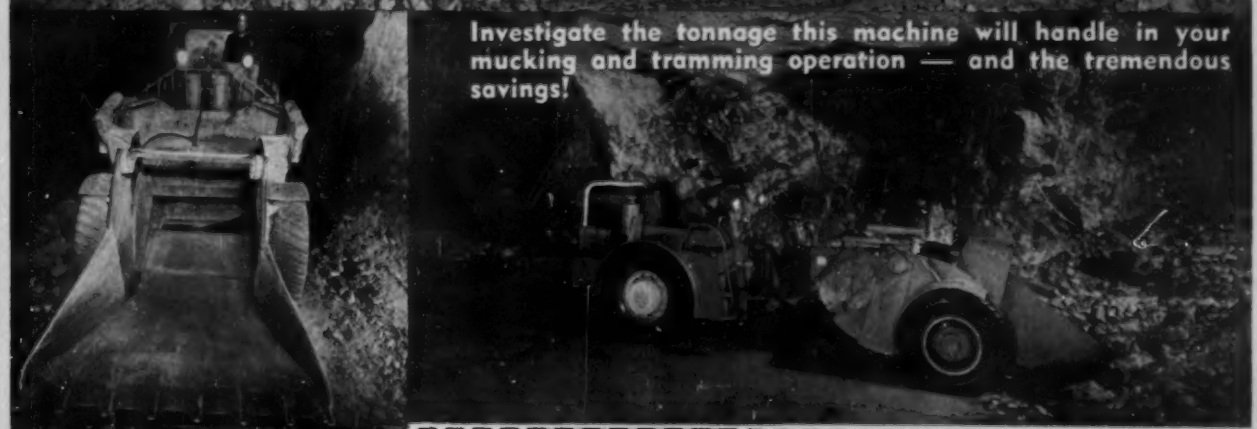

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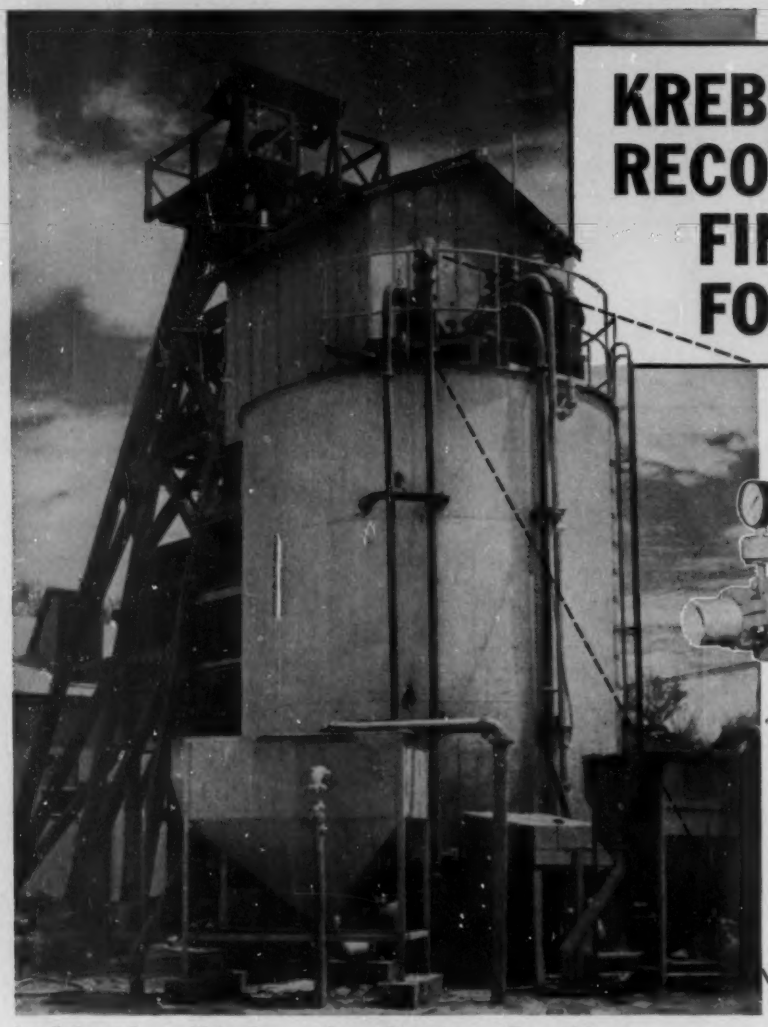
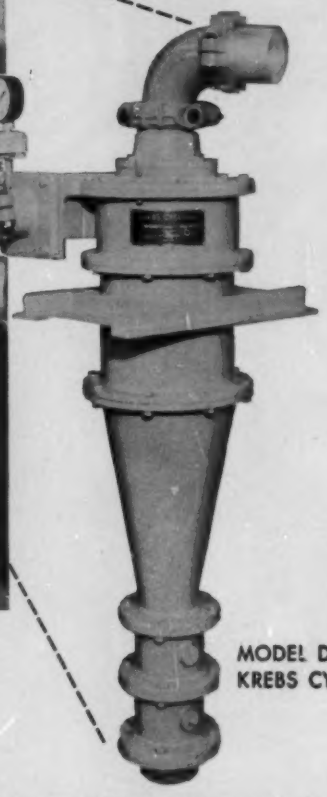


Installation at Banner Mining Company Copper Operation near Tucson, Arizona



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SIZING—	FEED	OVERFLOW	UNDERFLOW
% +100	4.9		6.2
+150	10.2		13.0
+200	12.7		16.2
+325	25.2		32.2
-325	**47.0**	**100.0**	**32.4**

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MINING ENGINEERING DRIFT

ENGINEERING EDUCATION

If you have not yet made your Annual Meeting reservations, you should . . . soon. And when making those reservations, you should also plan to arrive in time for the Sunday session on education. "Mining Education—Phoenix or Dodo" is the bluntly stated theme of the afternoon SME session. The speakers are men from industry and there should be opportunity for pithy comment from the floor. The principal speaker on the evening session will be E. W. Pehrson on the topic of the U. S. mineral position.

Engineering Bachelor Degrees — 1959

The figures below, from a recent Engineering Manpower Commission release, explain why the Sunday session on education should be a must on your Annual Meeting Schedule!

Official 1959 figures are expected to be published by the U. S. Office of Education in the near future. The following are our [EMC] estimates for 1959 and our [EMC] forecast for 1960:

From Colleges with ECPD Accredited Curricula	1958 Actual	1959 Estimated	1960 Projected
Aeronautical	1188	1300	1285
Agricultural	359	360	350
Chemical	2920	3025	2975
Civil	4673	5050	4975
Electrical	8712	9500	9400
General	683	710	685
Industrial	1783	1875	1825
Mechanical	7859	8425	8350
Metallurgical	**662**	**680**	**670**
Mining	**220**	**205**	**190**
Petroleum	**680**	**685**	**660**
All Others	1477	1800	1750
Total	31216	33615	33115
From other Colleges	4116	4350	4300
GRAND TOTAL	35332	37965	37415

Data for 1959 and 1960 represent scaling down of earlier estimates because retention rates in recent years have decreased. The 1959 graduating class (close to 38,000) started in 1955 with 72,825 freshmen; although the freshmen class in the following year (1956) was larger—77,738—it now appears likely that the number graduating (four years later) will be smaller. Within the past five or six years the trend in degrees by curricula distribution have shown: Electrical gaining steadily (now 27%); Civil dropping (now 15%) while Mechanical (25%), Chemical (10%) and Industrial (5%) have remained fairly constant (*Engineering Manpower Commission press release.*)

DON'T FORGET YOUR SME PREPRINT COUPONS FOR THE ANNUAL MEETING — COMPLETE PREPRINT AVAILABILITY LIST FOR MAIL ORDERS WILL APPEAR IN THE FEBRUARY ISSUE.

—Rixford A. Beals

This impressive installation at Kiruna, Sweden, demonstrates a major benefit of ASEA Multi-Rope Friction Hoists: *low initial installation cost.*

Each of these ASEA Hoists has a skipload of 22 tons and is designed for a depth of 1500 feet, maximum speed 2200 feet per minute.

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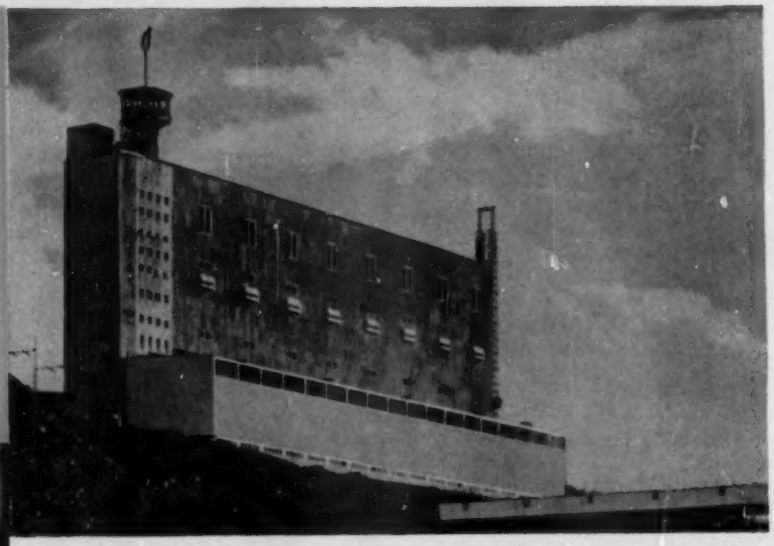
Total capacity: 4600 tons per hour



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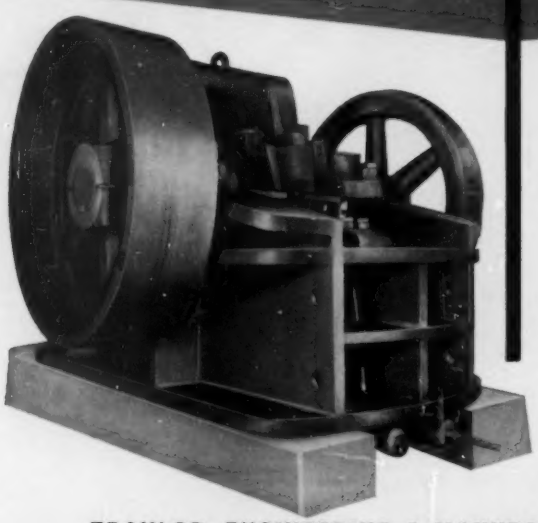

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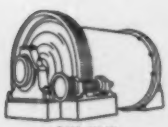

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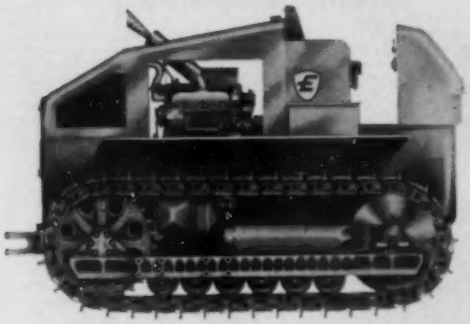

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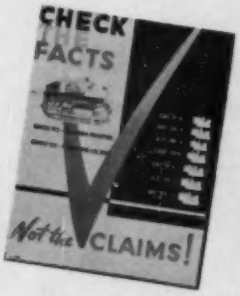

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ABSTRACTS OF SME ANNUAL MEETING PAPERS

October 20th was the deadline for abstracts published in the December issue (pages 1223-1232). The additional abstracts which appear on this page and the next were received by deadline for the January issue. Any abstracts subsequently received will appear in the regular Abstracts column (included in the Mineral Information Section of MINING ENGINEERING) in the issue for which deadline is met. Publication of abstracts does not indicate Preprint availability. Lists of all preprints available will be handed out at the Statler-Hilton Hotel during the Annual Meeting and an Availability List for mail orders will be published in the February 1960 issue. **DO NOT ORDER PAPERS UNTIL THESE LISTS APPEAR.**

COAL DIVISION

Utilization and Safety

The Communications Challenge of Automation by *J. E. Osmanski*—Almost everyone agrees that technological progress is a good thing—in the long run and especially if it does not affect his job right now. The bituminous coal industry has, in the last decade, increased its output per man per shift 101 percent. Advanced mechanization has contributed a major portion of this improvement in productivity. Very few of our employees and, publicly, none of our union officials and not a single one of our management oppose this kind of progress—in the long run. It is the immediate short-range effects that cause the controversy.

In our industry's recovery from the 1958 recession and the 1959 steel strike, production has increased faster than employment. Whatever the cause of the current disparity between production increases and the rate of recall of our laid off workers, it is certain that mechanization is playing its part. Most authorities in the field of automation agree that the trend toward automation can not be stopped. It is coming fast. It, thus, must be mastered and lived with.

To get the story of automation to its workers, management must take its employees into its confidence as much as possible. Of course, management can not consult its employees about the desirability of mechanizing in the first place. That should remain exclusively a management decision. However, prior to implementing the decision and following the installation of the machines there are some definite challenging obligations that management must face in its move toward automation. Management must train or re-train. Management, in collaboration with the community, must re-locate its laid off workers or assist in the development of new industries, particularly in a one or two industry community. Through educational experiences, management must help its workers to understand the economics of the trend toward automation. Management must further improve the worker's understanding of his benefits in this technological advance. No one can enumerate all the ways that a particular company can use to communicate to its workers sufficient data to improve their understanding of the benefits and the possible harmful effects. This is a choice for the individual company itself to make. However, the basic guiding principles of good communications can be helpful to the company that wants to cushion the blow and to improve the adjustment of retained workers to the new conditions of the automated era.

COUNCIL OF ECONOMICS

Fuel Economics

Trends in Property Acquisitions and Mergers in the Oil Industry Since 1954 by *H. Marshall Farrier*—The paper is concerned with mergers and acquisitions as a means of meeting competitive pressure. It presents a statistical breakdown of the property transfers which occurred in the oil industry between Jan. 1, 1954 and Oct. 1, 1959, showing the frequency with which certain types of properties were acquired in each of the years studied. In addition, it discusses the principal economic conditions which stimulated many of these property transfers, comments on the effects of these mergers and acquisitions on the consuming public, and indicates the rate at which mergers may be expected during the next three or four years and the types of properties which will probably be acquired. (**Note:** *This is a correction of the abstract published on page 1224 of the December issue*).

Mineral Economics

CORRECTION—The following abstracts, published in the December 1959 issue, page 1225, were included under Council of Economics **Incentive Symposium: Minerals and Monopoly—Formula for Soviet Success** by *Alexander Gakner* and **Rich Mineral Resources Spur Communist China's Bid for Industrial Power** by *K. P. Wang*. They should have been included under the session **Mineral Economics.**

St. Lawrence Seaway and the Canadian Mineral Industry with Particular Reference to Iron Ore by *R. B. Elver*—The St. Lawrence Seaway, a deep water canal system between Montreal and Kingston, was opened for navigation in April, 1959. Prior to the opening of the new Seaway, small canalers and a few deep-sea carriers were the only ships able to journey past Montreal into Lake Ontario. Thus it was necessary for many tons of bulk and general cargo to be shipped all-rail to or from east coast ports or to be transshipped from larger boats to canalers. With the opening of the new Seaway system, large Great Lake bulk carriers and a much larger percentage of the world's shipping fleet are now able to sail directly from the sea to the heart of industrial North America.

In this paper an attempt is made to evaluate the effects of the new Seaway on Canada's mineral industry, with particular reference to iron ore. Because the Seaway has been in operation for only one year this paper must be considered only an interim report. Earlier estimates of commodity tonnages that would flow through the Seaway are examined in the light of recent developments. Although several mineral commodities such as coal, petroleum and non-ferrous ores are discussed, the accent in this paper is on the iron ore industry because of its relatively large importance in estimated Seaway traffic.

Incentive Symposium

Incentive Bonus Systems by *James L. McGregor*—It is intended to show: the types of bonuses in use, those based on quality or quantity vs. those that merely increase the rate of pay; the reasons for using this method of payment, such as utilizing extra skills, extra effort, and obtaining additional production with the overall purpose to reduce unit costs by increasing output per man hour; the weakness or faults of bonus plans, and their effect on the employees with respect to incentive pay scales vs. fixed rates; the results obtained by use of incentive plans and administration and application of those now in use.

INDUSTRIAL MINERALS DIVISION

Cement, Lime, and Gypsum

Trends in Construction and Architecture and Their Effects on Consumption of Industrial Minerals by *A. Allan Bates*—Construction trends of significant enduring character always result from technological changes or advances. Occasionally these advances assume immediate and abrupt importance as exemplified by the sudden recent rise of prestressed concrete. More frequently the effects of major technological changes take place through impact on sociological organization: thus, the internal combustion engine and the telephone have largely induced the vast trend toward urbanization now in progress. To project such presently predictable trends into the next two decades is a useful, though inexact, exercise of technico-economics. The portents indicate a greatly increased demand on producers of industrial minerals both in tonnage and in quality. Thus, as production of structural concrete becomes an assembly line factory operation, the quality of all components, including aggregates, must necessarily be subject to increasingly rigorous quality control.

Abrasives and Fillers

Missouri-Oklahoma Type Tripoli by *Everett H. Dobbs*—Missouri-Oklahoma Tripoli is a soft, friable, porous silica of double-refracting variety. It has been used for 70 years as the principal abrasive base for the finishing of non-ferrous metals. This report describes the history, occurrence and preparation. The production methods illustrated are those used by American Tripoli Division, The Carborundum Company.

MINERALS BENEFICIATION DIVISION

Materials Handling and Mill Design

Setting Up a Project Organization for Efficient Mill Design by *Robert K. Young*—The obtaining of maximum efficiency in utilizing an engineering organization for mill design requires well planned and systematic application of manpower during each phase in the development of a project. This paper discusses methods for analyzing a mill design project to determine its organizational requirements during each stage, and describes the modern techniques commonly used in arranging a project group within an engineering organization.

Considerations in the Selection of Grinding Equipment by *R. J. Russell*—Grinding is an important unit process in industry and frequently a major item of cost. Experience, grinding history and test work make possible an economic evaluation so that a proper selection of grinding equipment can be made from the many types available.

Laboratory Experiments and the Relation to Plant Design by by *John D. Grothe*—The paper stresses the interrelation, in general terms, between the establishment of the laboratory program, information available from manufacturers, process economics, variables and nature of samples and the experience of the designer. The conclusion is advanced that in spite of the great progress in mathematical analytical methods and statistical computation, metallurgical plant design is an art rather than a science.

MINING AND EXPLORATION DIVISION

Underground Mining

Development of the El Salvador Mine by *H. E. Robbins, W. H. Dunstan, and T. H. Dudley*—The El Salvador mine of the Andes Copper Mining Company is situated about twenty miles north of Potrerillos, Chile, where the company has been mining and smelting copper ore for many years.

Exploration of the new property started about 1950 and after several years disclosed a porphyry orebody of about 375 million tons with an average grade of 1.5% total copper.

It was decided that the mining method that best suited the conditions encountered was block caving. Accordingly, a main haulage level was driven to receive ore by gravity through two ore pass and ore bin systems, from two higher elevation mining

levels. Ore is delivered to a new 24,000 tons per day plant which was built a short distance from the portal of the main haulage level.

Small Mine Operation—Shattuck Denn's Bardon Mine by *T. W. Newell and C. W. Appelin*—This paper by T. W. Newell and C. W. Appelin of Shattuck Denn Mining Corporation is an effort to briefly outline the company's approach to the mining of a relatively small uranium ore body in southeast Utah. The equipment utilized and planning employed are set forth to distinguish the obvious difference between large scale and small operations.

The Sinking of Two Shafts for the New Statemine Beatrix by the Drilling Method by *J. M. Weehuizen*—The coal-bearing carboniferous rock in the Dutch mining district is almost completely covered by an overburden of soft water-bearing strata, which, at the site of the new shafts, has a thickness of nearly 1600 ft. The sinking of new shafts through this overburden is a costly and time-devouring affair. Both Beatrix shafts have a diameter of 18′ 4½″ and stand 328 ft apart. From the two available sinking methods, either the freezing method of Poetsch or the drilling-method of Honigmann—de Vooys, the latter has been preferred, not only because of its relative cheapness under the prevailing conditions, but primarily because of the fact that the application of the drilling process lends itself admirably for the adoption of special type of lining of steel, concrete and bitumen, as proposed by de Vooys. This lining has a certain flexibility and can stand considerable soil movement without being deformed in such a way as to show leakages or as to loose part of the hoisting capacity of the shafts. The shafts were drilled to a diameter of 25 ft through 1574 ft of overburden and through about 100 ft of carboniferous. The drilling itself started in 1955 and was finished in 1959, whereafter the insertion of the floating lining took only a few weeks. Since then normal sinking operations in the underlying carboniferous rock have been started. Both shafts are planned for a total depth of approximately 2500 ft.

Geophysical

Electromagnetic and Induced Polarization Studies in Maine by *L. A. Anderson, E. B. Ekren, and F. C. Frischknecht*—During the summers of 1957, 1958, and 1959, the U. S. Geological Survey made experimental electromagnetic and induced polarization studies in four areas in north-central Maine. The principal objectives were to compare the results obtained with the two methods over known sulfide deposits and to evaluate the methods as aids to geologic mapping.

Large induced polarization and electromagnetic anomalies were observed over deposits of sulfide minerals at Ore Mountain, two miles west of the Katahdin Iron Works; at Black Narrows on Moxie Pond, six miles east of The Forks; and at Crawford Pond, 17 miles northwest of Rockland. In each of these areas there are massive and continuous deposits of pyrrhotite containing small amounts of other sulfide minerals. Disseminated sulfides occur in zones surrounding the major pyrrhotite masses.

The electromagnetic method was more useful than the polarization method in detecting significant changes in conductivity and distribution of sulfides within the pyrrhotite deposits. Large induced polarization anomalies were obtained over zones of disseminated minerals that cause only small electromagnetic anomalies.

A sequence of metavolcanic and metasedimentary rocks west of Patten was revealed by a prominent anomaly observed along an induced polarization traverse. Electromagnetic measurements along this traverse showed the presence of a single narrow zone of conductive rocks which was traced for several miles by additional traverses.

Location of Clay Deposits by Combines Self-Potential and Resistivity Surveys by *Gerardo W. Gross*—A commercial deposit of white kaolinite clay contained in the sandy overburden of the Cambrian Gatesburg formation in Central Pennsylvania was successfully mapped by combined SP and resistivity methods and results were checked by drilling. Resistivity minima in the range between roughly 200 and 3500 ohm-meters coupled with second-order SP maxima of 50-60 mV contrast were found to characterize commercial white kaolinite clay beneath not more than 30-40 ft of sandy overburden in the area studied. This investigation supports the hypothesis, established previously, that certain SP phenomena may reasonably be ascribed to diffusion and membrane potentials produced by interaction of clay lenses, sandy matrix, and groundwaters. The success of this test proves that this prospecting technique can assist in locating clay deposit in sandy overburden derived from the weathering of sandstones and carbonate rocks such as the Cambrian formations of Central Pennsylvania.

SOCIETY OF MINING ENGINEERS

TECHNICAL PROGRAM

AIME Annual Meeting, February 14-18
Statler-Hilton Hotel, New York

NOTE: See formal AIME Annual Meeting Program to be distributed at the meeting for specific times and rooms for all sessions.

Coal Division

Monday, February 15, AM

VENTILATION OF GASSY MINES

Chairmen to be announced

Ventilation of Conventional Development in Gassy Coal Mines: *Leonard Sargeant*, Pocahontas Fuel Company

Face Ventilation in Development with Continuous Miners: *William Poundstone*, Christopher Coal Company

Efficient Pillar Extraction by Means of Exhaust Ventilation: *Lonnie D. Ellison*, Island Creek Coal Company

Ventilation of Very Gassy Mines Making Use of Large Diameter Bore Holes: *David C. Ridenour*, Olga Coal Company

Monday, February 15, PM

SYMPOSIUM ON FINE COAL RECOVERY

P. L. Richards and D. A. Dahlstrom, *Chairmen*

Solving the Flocculation Problem: *M. P. Corriveau*, Clinchfield Coal Company and *H. F. Coil*, Dow Chemical Company

Panelists: *W. L. McMorris, Jr.*, U.S. Steel Corp.; *W. H. Reck*, Western Machinery Company; *R. L. Llewellyn*, Eastern Gas & Fuel Assoc. *H. B. Charmbury*, Pennsylvania State University, *H. J. Gisler*, Denver Equipment Company

Tuesday, February 16, AM

NEW GADGETS, METHODS & EQUIPMENT

Chairmen to be Announced

Mechanized Tie Tamping of Haulage Road: *D. H. Davis*, Consolidation Coal Company

Tube Furnace Method for Rapid Determination of Sulfur in Coal: *George E. Keller* and *G. Dale Coe*, U. S. Steel Corp.

Continuous and Automatic Measurement of Moisture in Coal by Capacitance: *Loy A. Updegraff*, Bituminous Coal Research, Inc.

Coal Seam Degasification by Horizontal and Vertical Drilling: *G. R. Spindler*, West Virginia University, and *Wm. N. Poundstone*, Christopher Coal Co.

Hydraulic Mining of Coal: *James J. Dowd*, U. S. Bureau of Mines

Drilling Large Diameter Bore Holes: *Victor Zeni*, Zeni-McKinney-Williams Corp.

Wednesday, February 17, AM

UNDERGROUND MINING

Chairmen to be Announced

Daily Maintenance and Complete Overhaul of Continuous Miners: *Joseph Mason*, Mountaineer Coal Company

Selecting the Proper Type of Continuous Miner: *John A. Stachura*, Enoco Collieries, Inc.

Moss Number 3 Mine—The Materials Handling Aspects: *F. M. Morris*, Clinchfield Coal Company

Wednesday, February 17, PM

UTILIZATION AND SAFETY

Chairmen to be Announced

A Field Study in Acid Mine Drainage: *J. Richard Lucas*, Ohio State University

The Exploration and Mining of Raw Materials—Production of Refractory Products—Application for the Utilization of Coal: *O. W. Kamper*, Harbison-Walker Refractories Company

Communications Challenge of Automation: *J. E. Osmanski*, Island Creek Coal Company

Thursday, February 18, AM

PREPARATION

Chairmen to be Announced

High Head Slurry Pumping: *W. D. Haentjens*, Barret, Haentjens and Company

Crushing of Anthracite for the Reduction of Domestic to Steam Sizes: *P. D. Rao, H. B. Charmbury*, and *D. R. Mitchell*, Pennsylvania State University

Cyclone Cleaning of Fine Coal: *H. F. Yancey* and *M. R. Geer*, U. S. Bureau of Mines

Council of Economics

Monday, February 15, PM

FUEL ECONOMICS

Warren B. Davis and George A. Lamb, *Chairmen*

A Method of Projecting U.S. Petroleum Supply: *Paul W. McGann*, U. S. Bureau of Mines

A New Performance Measure to Test the Contribution of the Petroleum and Natural Gas Industry in an Expanding Economy: *Virgil L. Barr*, U.S. Bureau of Mines

The Question of Governmental Oil Import Restrictions: *Wm. H. Peterson*, New York University

Trends in Property Acquisitions and Mergers in the Oil Industry Since 1954: *H. Marshall Farrier*, Continental Oil Company

Bituminous Coal Consumption—Estimating its Long Term Growth and Annual Variation: *W. Gibson Jaworek, J. J. Schanz, Jr.*, Pennsylvania State University

Tuesday, February 16, AM

MINERAL ECONOMICS

Sheldon P. Wimpfen and John M. Warde, *Chairmen*

St. Lawrence Seaway and the Canadian Mineral Industry with Particular Reference to Iron Ore: *R. B. Elver*, Canadian Dept. of Mines & Technical Surveys

World Trade in Metal Raw Materials: *John D. Ridge*, Penna. State University

U. S. Strategy and National Stockpile Programs: *John D. Morgan, Jr.*, Consultant

Minerals and Monopoly—Formula for Soviet Success: *Alexander Gakner*, U.S. Bureau of Mines

Rich Mineral Resources Spur Communist China's Bid for Industrial Power: *K. P. Wang*, U.S. Bureau of Mines

Sources and Trade Routes of U.S. Raw Materials (U.S. Life Lines): *Wallace D. Barlow*, Office of Naval Material

Thursday, February 18, AM

SYMPOSIUM: APPLICATION OF INCENTIVE METHODS IN THE MINING INDUSTRY

C. DeWitt Smith, *Moderator*

The Butte Contract System: *V. D. O'Leary*, The Anaconda Company

Incentive Pay System at the Homestake Mining Company: *Joel K. Waterland*, Homestake Mining Company

Incentive Bonus Systems: *James L. McGregor*, St. Joseph Lead Co.

Foremen's Incentive Plan: *Arthur E. Belton*, Mountaineer Coal Co.

Production Management: *Morley H. Mathewson*, Int. Min. & Chem. Corp.

Council of Education

Sunday, February 14, PM

MINING EDUCATION: PHOENIX OR DODO

Stefan Boshkov and Malcolm Wane, *Chairmen*

Panelists: *H. R. Rice*, University of Toronto; *J. D. Reilly*, Hanna Coal Company; *A. W. Knoerr*, E & MJ Journal; *S. D. Michaelson*, Kennecott Copper Corp.; *C. M. Brinckerhoff*, The Anaconda Company

COUNCIL OF EDUCATION EVENING SESSION

U.S.A. in Minerals—Eagle or Ostrich: *E. W. Pehrson*, Lecturer in Mineral Economics, Columbia University

Industrial Minerals Division

Monday, February 15, AM

RARE AND RADIOACTIVE MINERALS

Joint Session with SEG

Ralph H. Wilpolt and Richard M. Foose, *Chairmen*

Non-Pegmatitic Deposits of Beryllium in the United States: *Wallace R. Griffitts*, U. S. Geological Survey

Pegmatites and Their Mineralization in the Storm Mountain Area, Larimer Co., Colo.: *Margaret Fuller Boos*, Consultant

Evaluation and Marketing of Rare Earth Deposits, Ores and Concentrates: *Judson H. Whitman*, Michigan Chemical Corp.

Niobium at Powderhorn, Colorado: *Robert M. Grogan*, E. I. duPont de Nemours and Company

The Gamma Ray-Neutron Beryllium Detector as a Reconnaissance Tool: *Pauline and Louis Moyd*, Consultants

Monday, February 15, PM

INDUSTRIAL WATERS

Wilbur T. Stuart and Jack B. Braham, *Chairmen*

Water: Industrial Mineral—and Industrial Nuisance: *Raphael G. Kazmann*, Consultant

The Cost of Converted Water: *W. Sherman Gillam*, U.S. Dept. of the Interior

Development of Extreme Settings on Deep Well Turbine Pumps: *Claude E. Wykes*, Layne & Bowler Pump Co.

Underground Gas Storage Effects on Underground Waters: *Douglas Ball*, Ball Associates, Ltd.

Use and Evaluation of Water for the Copper Mining Industry: *S. D. Michaelson*, Kennecott Copper Corp.

Tuesday, February 16, AM

ABRASIVES AND FILLERS

Robert S. McClellan and H. L. King, *Chairmen*

A Study of the Abrasive Action of Fine Powders: *L. E. Weymouth, F. L. Kadey, Jr.* and *F. B. Hutto, Jr.*, Johns-Manville Research Center

Some Beneficiation Techniques Applicable to Mineral Fillers: *Donald R. Irving*, U. S. Bureau of Mines

Nonmetallic Mineral Fillers in Plastics: *Robert D.*

Thomson, U.S. Bureau of Mines
To be Announced: *James A. Barr, Jr.*, Barr & Associates
Missouri-Oklahoma Type Tripoli: *Everett H. Dobbs*, American Tripoli Div., The Carborundum Company

INDUSTRIAL MINERALS DIVISION LUNCHEON

Luncheon Speaker: Dr. *Bruce C. Heezen*, Lamont Geological Observatory: Submarine Topography of the Western Atlantic

Wednesday, February 17, AM

CERAMIC RAW MATERIALS

Wayne E. Brownell and Sandford S. Cole, *Chairmen*

Inorganic Materials Research in the USSR: *W. G. Lawrence*, Alfred University
Lithium in the Ceramic Industry: *Robert J. Longenecker*, Foote Mineral Company
Applications of Lanthanon Oxides and Other Compounds in Ceramics: *G. L. Ploetz* and *A. T. Muccigrosso*, General Electric Company
Synthetic Mullite as a Ceramic Raw Material: *Everett A. Thomas* and *Karl W. Smith*, The Chas. Taylor Sons Company

Wednesday, February 17, PM

CHEMICAL RAW MATERIALS

F. C. Kruger and G. Richards Gwinn, *Chairmen*

Development of a Bauxite Deposit Using Dredging as the Stripping Method: *J. G. Cazort, Jr.*, Suriname Aluminum Co.
The Phosphate Raw Materials of Tennessee: *Robert E. Hershey*, Tennessee Division of Geology
Refractory Chrome Ore—World Survey: *John M. Warde*, Union Carbide Ore Co.
Zoning and Grade Control of Sulphur at the Tennessee Copper Co., Copperhill, Tenn.: *Owen Kingman*, Tennessee Copper Co.
Solution Extraction of Salt Using Wells Connected by Hydraulic Fractures: *Carl A. Bays*, C. A. Bays & Assoc., *W. C. Peters*, Food Machinery & Chemical Corp., and *M. Wm. Pullen*, Purdue University
Trends in Production and Use of Magnesium Ores and Compounds: *Hazel B. Comstock*, U.S. Bureau of Mines

Thursday, February 18, AM

CEMENT, LIME AND GYPSUM

Herbert E. Dux and John A. Wolfe, *Chairmen*

Concrete Technology in the U.S.S.R.: *James D. Piper*, Portland Cement Association
The Role of Gypsum in Portland Cement: *Warren H. Weisz*, Portland Cement Association
Use of the Coulter Counter for Particle Size Analysis of Cement and Related Material: *O. E. Brown*, Marquette Cement Mfg. Co.
Application of an Automatic X-ray Spectrograph to the Cement and Mining Industries: *William R. Kiley*, Philips Electronics, Inc.
Trend in Construction and Architecture and Their Effects on Consumption of Industrial Minerals: *A. Allan Bates*, Portland Cement Association

Thursday, February 18, PM

DIMENSION STONE & SLATE WITH MINERAL AGGREGATES

Howard L. Hartmen and James V. Thompson, *Chairmen*

Developments and Research in the Sawing of Dimension Stone: *Frank D. Hoyt* and *Howard L. Hartman*, Pennsylvania State University
Quarried Stone Meets the Challenges of Contemporary Architecture: *Arland R. Krueger*, Toledo Cut Stone Company
Progress Report on the Beneficiation of Aggregates by Heavy Media Separation: *D. W. Jenkinson*, Western Machinery Corp.
Factors Influencing the Establishment of a Clay Lightweight Aggregate Plant: *Stanley A. Feitler*, U.S. Bureau of Mines
Fragmentation Studies in a Georgia Granite: *Douglas Castleberry*, The W. S. Frey Company
Lightweight Clay Block Using Vermiculite: *Gilbert C. Robinson*, Clemson Agricultural College

Minerals Beneficiation Division

Monday, February 15, AM

COMMINUTION SYMPOSIUM
ENERGY-SIZE REDUCTION RELATIONSHIPS

Chas. L. Sollenberger and R. S. Shoemaker, *Chairmen*

The Size Distribution Shift in Grinding: *G. Agar*, M.I.T., and *R. J. Charles*, General Electric Research Laboratory
Kinetics of Comminution: *N. Arbiter*, Columbia University and *U. N. Bhrany*, U. S. Steel Corp.
Energy-Size Reduction Relationship for the Grinding of Quartz: *J. H. Brown*, U.S. Steel Research Center; *S. R. Mitchell*, MIT, and *M. Weissman*, North American Aviation, Inc.
Retention Time in Continuous Vibratory Ball Milling: *D. W. Fuerstenau*, University of California
Energy Input and Size Distribution in Comminution: *R. Schuhmann, Jr.*, Purdue University
Energy-Size Reduction Relationships at Fracture for Single Particles: *Bert Bergstrom*, *C. L. Sollenberger*, and *Will Mitchell, Jr.*, Allis-Chalmers Mfg. Co.
Theory of Fracture and Comminution of Brittle Solids: *J. J. Gilvarry*, and *B. H. Bergstrom*, Allis-Chalmers Mfg. Co.

Monday, February 15, PM

CONCENTRATION

O. F. Tangel and L. J. Bechaud, Jr., *Chairmen*

Development of a New Dry Method for Mineral Separation: *R. J. Brison* and *O. F. Tangel*, Battelle Memorial Institute
Beneficiation of Rock Salt at the Detroit Mine of International Salt Company: *W. C. Bleimeister*, International Salt Co., Inc. and *R. J. Brison*, Battelle Memorial Institute
The Copper Segregation Process: *Carl Rampacek* and *W. A. McKinney*, U.S. Bureau of Mines
Magnetic Recovery of Germanium Sulphide with the Franz Ferrofilter: *M. Bouchat*, *A. DeTiege*, and *D. Robert*, Union Miniere du Haut-Katanga

Tuesday, February 16, AM

SOLID FLUID SEPARATION

Wm. T. Marston and Frank M. Howell, Jr., *Chairmen*

Measurement and Control of Pulp Density: *L. E. Sausa* and *J. E. Martinson*, Union Carbide Nuclear Company
Thickener Control at Marmoraton Mining Co.: *Wm. M. Aubrey, Jr.*, Bethlehem Steel Co.

Wednesday, February 17, AM

MATERIALS HANDLING AND MILL DESIGN

D. G. Ashe and A. A. Wallach, *Chairmen*

Intraplant Transportation and Handling of Bauxite at Suralco's Paranam, Suriname, S. A. Works: *Philip Dorrance*, Aluminum Company of America
Influence and Application of Rope Sideframe Belt Conveyors to Surface Coal Handling Facilities and Prep-

aration Plant Design: *E. Morgan Massey*, Massey Coal Mining Company

A Project Organization for Efficient Mill Design: *Robert K. Young*, Western Knapp Engineering Company

Considerations in the Selection of Grinding Equipment: *R. J. Russell*, Hardinge Company, Inc.

Laboratory Experiments and their Relation to Plant Design: *John D. Grothe*, Dorr-Oliver, Inc.

Wednesday, February 17, AM

BASIC SCIENCE SYMPOSIUM ON SURFACE PHENOMENA FOR MINERAL, CERAMIC, AND METALLURGICAL SYSTEMS

Joint Session with IMD and EMD of The Metallurgical Society

(Arranged by Basic Science Committee of Minerals Beneficiation Division)

P. L. deBruyn and R. J. Charles, *Chairmen*

Elementary Concepts of Surface Energy and Their Applications in the Metallurgical Industry: *C. S. Smith*, University of Chicago

The Influence of Solutes on Interfacial Tensions and on the Contact Angle: *J. Th. G. Overbeek*, University of Southern California, and *P. L. deGruyn*, Massachusetts Institute of Technology

Kinetics of Wetting and Surface Energies of Solid Metals: *C. M. Adams*, Massachusetts Institute of Technology

Some Aspects of the Foaming of Fused Silicates: *C. L. McCabe* and *C. F. Copper*, Carnegie Institute of Technology

Wednesday, February 17, PM

OPERATING CONTROL

L. A. Roe and F. M. Lewis, *Chairmen*

The Mill with No Operators: *Wayne C. Hazen*, Kerr-McGee Oil Industries, Inc. and *S. Power Warren*, Consultant

Basic Concepts and Automatic Control of Continuous Filtration: *D. A. Dahlstrom*, The Eimco Corp.

Automatic X-ray Fluorescence Analysis of Titanium in Ilmenite: *Erkki Laurila, O. Castren* and *L. Saari*, University of Helsinki

The Infrared Radiometric Method and its Application to Remote Temperature Measurement: *G. R. Mitchell, H. L. Berman* and *A. E. Goldberg*, Radiation Electronics Co.

Wednesday, February 17, PM

BASIC SCIENCE SYMPOSIUM ON SURFACE PHENOMENA FOR MINERAL, CERAMIC, AND METALLURGICAL SYSTEMS

Joint Session with IMD and EMD of The Metallurgical Society

(Arranged by Basic Science Committee of Minerals Beneficiation Division)

P. L. deBruyn and S. Korman, *Chairmen*

Crystal Growth in Solids: *D. Turnbull*, General Electric Company

Surface Chemistry and the Kinetics of Sintering Processes: *W. D. Kingery*, Massachusetts Institute of Technology

Geometric Equilibria and Nonmetallic Microstructures: *L. H. Van Vlack*, University of Michigan

Graphite Formation and Surface Tension in Cast Iron: *J. Keverian*, General Electric Company

Thursday, February 18, AM

MAGNETIC ROASTING OF IRON ORES

M. E. Volin and Fred H. Bunge, *Chairmen*

Mechanism of Magnetizing Roasting of Iron Ores: *J. E. Astier, P. Emery* and *A. Matraski*, IRSID, France

Magnetic Roasting of Iron Ores in a Traveling Grate Roaster: *Henry H. Wade* and *Norman F. Schulz*, University of Minnesota

The Magnetic Reduction of Jaspilite in a Shaft Furnace: *J. R. J. Edwards* and *S. G. Salamy*, The Broken Hill Proprietary Co. Ltd.

The Reaction of Low Grade Non Magnetic Iron Ores to Magnetic Roasting in a Fixed Bed: *W. H. Dailey, Jr.*, Surface Combustion Corp. and *F. H. Bunge*, M. A. Hanna Company

Some Factors Influencing the Physical Qualities of Iron Ore Pellets: *K. E. Merklin* and *M. H. Childs*, Pickands-Mather & Co.

Development of Beneficiation Technology for Hematite Ores: *N. P. Titkov*, Mekhanobr Institute, Leningrad

MINERALS BENEFICIATON DIVISION LUNCHEON

Luncheon Speaker: *Norman L. Weiss*, recipient, Robert H. Richards Award

Thursday, February 18, PM

CHEMICAL PROCESSING

F. T. Davis and E. S. Allen, *Chairmen*

Application of Continuous Filtration to Precipitate Dewatering: *R. C. Emmett* and *D. A. Dahlstrom*, The Eimco Corp.

A Study of Oxidation and Cyanide as an Oxidation Catalyst in Pressure Leaching of Uranium: *D. C. McLean*, Cyanamid International, and *Victor E. Padilla*, Colorado School of Mines Research Foundation

The Recovery of Molybdenum by Liquid-Liquid Extraction from Uranium Mill Circuits: *C. J. Lewis*, Colorado School of Mines Research Foundation, and *J. E. House*, General Mills, Inc.

Commercial Separation of the Heavy Rare Earths by Ion Exchange: *J. R. Gump*, Michigan Chemical Corp.

Mining and Exploration Division

Monday, February 15, AM

OPEN PIT MINING

John B. Knaebel and Howard A. Wilmeth, *Chairmen*

Industrial Accident Prevention and Health: *Paul L. Hunter*, Kennecott Copper Corp.

The Use of Digital Computers in the Mining Industry: *Peter B. Nalle* and *L. W. Weeks*, Riverside Cement Co.

Explosions Research Applied to Mine and Quarry Blasting: *Clifton W. Livingston*, Barodynamics, Inc.

Portable Crusher in Open Pits and Quarries Operation: *B. J. Kochanowsky*, Pennsylvania State University

Monday, February 15, PM

UNDERGROUND MINING

Richard M. Stewart and Elmer A. Jones, *Chairmen*

Small Mine Operation—Shattuck Denn's Bardon Mine: *Thomas W. Newell* and *Carl W. Appelin*, Shattuck Denn Mining Corp.

The History and Development of the San Manuel Mine: *F. H. Buchella* and *J. F. Buchanan*, San Manuel Copper Corp.

Tri-State Zinc's Bowers-Campbell Operation: *Larry G. Hayes*, Bowers-Campbell Mine

Monday, February 15, PM

GEOPHYSICAL

R. K. Waring and B. F. Howell, Jr., *Chairmen*

The Comparison of I. P. and E. M. Survey over Sulfide Deposits in Maine: *Lennart Anderson, E. B. Ekren,* and *F. C. Frischknecht,* U.S. Geological Survey

Airborne Gravity Measurements: *Lloyd G. D. Thompson,* Air Force Cambridge Research Center

Model Studies of an Apparatus for Electromagnetic Prospecting: *Harold E. Swanson,* The New Jersey Zinc Co.

Location of Clay Deposits by combined S. P. and Resistivity Surveys: *Gerardo W. Gross,* Newmont Mining Company

Airborne AFMAG surveys in the Western United States: *William C. Kellogg,* Fairchild Aerial Surveys

Tuesday, February 16, AM

ROCK MECHANICS—OPEN PIT

Adolph Soderberg, *Chairman*

Underground Stress Instrumentation: *Robert Stefanko,* Pennsylvania State University

The Mechanics of Rock Slopes: *D. Hugh Trollope,* University of Melbourne

A Method for Determining the True Tensile Strength of Rock: *Niles E. Grosvenor,* Colorado School of Mines

Tuesday, February 16, AM

GEOCHEMICAL

Joint Session with SEG

Douglas R. Cook and Frank C. Canney, *Chairmen*

Status of Geochemical Prospecting in the USSR: *Herbert E. Hawkes,* University of California

Relationship of Graphite in Soils in Graphitic Zones: *William H. Dennen,* M.I.T. and *Harold Linder,* McPhar Geophysics Ltd.

Geological and Geochemical Factors in the Discovery of Blind Ore in the East Tintic District, Utah: *T. S. Lovering* and *H. T. Morris,* U.S. Geological Survey

Solubility of Copper in Natural Waters and its Application to Geochemical Prospecting: *J. A. Silman* and *R. M. Garrels,* Harvard University

Geochemical Patterns in Certain Ore Deposits: *A. W. Jolliffe,* Queen's University

Applied Geochemistry in the Canadian Precambrian Shield: *John E. Riddell,* Carleton University

Wednesday, February 17, AM

UNDERGROUND MINING

John Kostuik and Edward P. Leach, *Chairmen*

Development of the El Salvador Mine: *H. E. Robbins, W. H. Dunstan,* and *T. H. Dudley,* Andes Copper Mining Co.

Mining at Consolidated Dennison: *M. J. Bastiani,* Consolidated Dennison Mines Ltd.

The Sinking of Two Shafts for the New Statemine Beatrix by the Drilling Method: *J. M. Weehuizen,* Dutch State Mines

Wednesday, February 17, PM

JACKLING SESSION

L. H. Hart and R. J. Lacy, *Chairmen*

Need for a New Philosophy for Prospecting or How to Rig Prospecting Honestly: *Louis B. Slichter,* University of California

Plowshare Program: *Wilmot N. Hess,* Lawrence Radiation Laboratory

Thursday, February 18, AM

GEOLOGICAL

R. H. Carpenter and E. H. Wisser, *Chairmen*

Geological Procedure and Control at Steep Rock Iron Mines Limited: *C. J. Gauvin,* Steep Rock Iron Mines Ltd.

The Application of Geology to Exploration and Mining: *Harrison A. Schmitt,* Consultant

Title to be Announced: *A. V. Quine,* Lucky Mc Uranium Corp.

Title to be Announced: *Reno H. Sales,* Consultant

SEG PRESIDENTIAL ADDRESS—*J. L. Gillson,* E. I. duPont de Nemours, Inc.

Thursday, February 18, PM

IRON ORE GEOLOGY

R. W. Marsden and F. G. Pardee, *Chairmen*

Geology of the Nakina Iron Property, Ontario: *W. T. Swensen,* The Anaconda Co. (Canada) Ltd.

Iron Deposit of the Wabush Lake Area, Newfoundland, Labrador: *R. D. Macdonald,* Labrador Mining & Exploration Co. Ltd.

Petrology of the Magnetic Taconites of the Eastern Mesabi District, Minnesota: *James N. Gundersen,* University of Minnesota

Society of Economic Geologists

Joint Session with M&E

Monday, February 15, AM

The Genesis of the Sulfide Deposits of Northern New Brunswick—An Interpretation Based on Sulfur Isotopic Studies: *W. M. Tupper,* Carleton Univ., *M. L. Jensen,* Yale Univ., *P. Hurley,* M.I.T.

Mineralogy and the Question of Zoning, N. W. Illinois Zinc-Lead District: *J. C. Bradbury,* State Geological Survey

Unified Field Geology Applied to Beryllium Prospecting: *Einar C. Erickson,* University of Arizona

Distinctions Between Barren and Productive Intrusive Porphyries: *Bronson Stringham,* University of Utah

Structural Control and Localization of Gold-Bearing Lode in Kolar Gold Field, India: *S. Narayanaswami, Mohamed Ziauddin* and *A. V. Ramachandra,* India

AWARDS AND HONORS

To be presented to AIME and Society of Mining Engineers Members during Annual Meeting events. See official program.

James Douglas Gold Medal: *Augustus B. Kinzel*

Erskine Ramsay Gold Medal: *Raymond E. Salvati*

Robert H. Richards Award: *Norman Weiss*

Daniel C. Jackling Award and Lecture: *Louis B. Slichter*

Mineral Industry Education Award: *L. C. Uren*

Hal Williams Hardinge Award: *Samuel H. Dolbear*

William Lawrence Saunders Gold Medal: *Robert J. Linney*

Anthony F. Lucas Gold Medal: *A. C. Rubel*

Benjamin F. Fairless Award: *Charles M. White*

Rossiter W. Raymond Memorial Award: *Paul G. Shewmon*

Alfred Nobel Prize: *Paul G. Shewmon* (This is a Joint Award given by the five Founder Engineering Socs.)

AIME Honorary Members: *Andrew Fletcher*
John Meston Lovejoy
Henry DeWitt Smith
Wilfred Sykes
William Embry Wrather

CALENDAR OF EVENTS, AIME ANNUAL MEETING

To be held at the Statler-Hilton Hotel, February 14-18

Check official program booklet, distributed at the meeting, for any changes in times and places for each event listed.

Saturday, February 13, all day

10:00-5:00 **AIME Council of Section Delegates** Penn Top South

Sunday, February 14, PM

2:00 **SME Education Committee** Penn Top South
5:00-6:00 **Council of Education Cocktail Party** Georgian Room
6:00-7:30 **Council of Education Supper** Georgian Room
8:00 **Council of Education** Gold Ball Room
Speaker: *Elmer W. Pehrson*, USBM

Sunday, February 14, all day

SME Program Committee Meeting Washington Room

Monday, February 15, AM

9:30 **SME Board Meeting** Hartford Room
9:30 **SME Education Committee Meeting** Buffalo Room

Monday, February 15, PM

12:15 **AIME Welcoming Luncheon** Grand Ballroom
2:30 **SME Board Meeting** Hartford Room
2:30 **SEG Council Meeting** Buffalo Room
6:00 **AIME Cocktail Party** Sky Top, Penn Top
8:00 **AIME Dinner-Smoker** Grand Ballroom

Tuesday, February 16, AM

7:30 **MBD Scotch Breakfast** Terrace Ballroom
MBD Business Meeting Terrace Ballroom
7:30 **Breakfast, Drilling and Blasting Symposium** Hartford Room
9:00 **SME Nominating Committee** Buffalo Room

Tuesday, February 16, PM

12:15 **IndMD Luncheon** Terrace Ballroom
Speaker: *Bruce C. Heezen*, Lamont Geological Observatory
12:15 **Coal Division Luncheon** Penn Top Center
12:15 **Council of Economics Luncheon** East Room
2:30 **AIME All-Institute Session** Grand Ballroom
4:00 **AIME Annual Business Meeting** Grand Ballroom
4:30 **IndMD Business Meeting** Hartford Room
4:30 **Coal Division Open Business Meeting** Washington Room
6:00 **SME Cocktail Party** Georgian Foyer
6:00 **SME Head Table Cocktails** Buffalo Room
7:00 **SME Dinner** Georgian Room
9:00 **AIME Informal Dance** Terrace Ballroom

Wednesday, February 17, AM

7:00 **Grinding Breakfast** Terrace Room

Wednesday, February 17, PM

12:15 **M & E Division Luncheon** Gold Ballroom
4:30 **M & E Division Business Meeting** East Room
7:00 **AIME Annual Banquet** Grand Ballroom
following **AIME President's Reception** Ballroom Rotunda
10:00 **Dancing** Grand Ballroom

Thursday, February 18, AM

11:00 **SEG Presidential Address and Business Meeting** Penn Top North

Thursday, February 18, PM

12:15 **MBD Luncheon** Grand Ballroom
Speaker: *Norm L. Weiss*, Asarco
12:15 **SEG Cocktails and Luncheon** Ivy Suite

Note: The SME Preprint Center in the Statler-Hilton Hotel will be open at noon Sunday, and from 8:00 am to 6:00 pm, Monday through Thursday, February 14 through 18. Location: Mezzanine Registration area.

Bring Your SME Preprint Coupons to the Meeting

See February for Available Preprint List for Mail Orders

EXPLOSIONS RESEARCH APPLIED TO MINE AND QUARRY BLASTING

CLIFTON W. LIVINGSTON

SO many factors influence blasting results that theories and rules are usually dismissed as impractical; the practice prevailing today is arrived at by cut and try. Usually the first step is to experiment with drillhole patterns and spacing until an arrangement is found that gives best results. The next step is to experiment with different types of explosives and sequences of blasting until the most satisfactory degree of fragmentation is achieved and until no further reduction in cost is immediately apparent. Improved fragmentation is generally attributed to the type of powder used, the sequence in which the holes are blasted, or the use of millisecond delays.

Various types of drill rounds have been evolved in tunneling operations, underground development headings, and stoping, and various patterns of blasting in open pit mines and quarries. These practices usually are carried from mine to mine or from district to district, and great skill is exercised by those experienced in the art of blasting.

When the first atomic bomb was dropped, the status of blasting as an art rather than a science at once became apparent. The advice of mining people and explosives manufacturers was sought on a number of matters requiring a knowledge of how rock fails when subjected to impact or explosion. Unfortunately the information was not available, but fortunately research on explosions began and was directed toward discovering the fundamentals of behavior not only of rocks, but also of other materials of the earth's crust, including the oceans of the earth and the atmosphere above. At present, the search continues and has been extended to include the rarified atmosphere hundreds of miles above the surface of the earth where elementary particles of matter are widely separated.

C. W. LIVINGSTON is President, Barodynamics Co., Georgetown, Colo.

Types of Failure: When experiments were made under controlled test conditions with brittle-acting substances, it became apparent that the old crater theory of blasting described in Peele's *Mining Engineer's Handbook* did not apply. The former concept gave way to the shock wave reflection theory, which apparently is accepted today with little reservation, although it now appears to have been founded on incomplete knowledge.

Evidence recently has been obtained to demonstrate that at least three types of failure occur in blasting:

1) The shock type, characteristic of brittle-acting substances.

2) The shear type, characteristic of more plastic-acting substances.

3) The viscous-damping type, characteristic of composite substances such as snow, which consists of a brittle-acting elastic solid containing air-filled voids.

Evidence also has been accumulated to demonstrate that behavior of a given material is not constant and that brittle substances can be caused to deviate from ideal elastic behavior at high energy levels. Within certain specified limits, one material can be caused to behave like another. A concept known as "the theory of relative behavior of materials" was evolved, and from this the breakage process equation was developed. The equation applies not only to shock-type failure in blasting but also to shear types and viscous-damping types of failure.

The Breakage Process Equation: The breakage process equation recognizes the many factors influencing the results of blasting, but expresses them

in relation to energy, mass, and time. Research has not yet progressed to the stage where it is possible to describe in absolute units the relations between the energy of the explosive and the mass of material affected by the disturbance during the time required for it to pass from the explosion cavity through the material to various transition limits, but these relations can be described by the use of relative units and an equation of the form

$$\frac{V}{W} = E^n ABC$$

where

V = volume of material broken by the explosive, cu ft.
W = weight of the explosive, lb.
E = strain-energy factor.
A = energy utilization number.
B = materials behavior index.
C = stress distribution number.

A great deal of work remains before the natural laws that determine the form of the disturbance that passes outwardly from the explosion into the material can be stated, or before the action affecting the mechanical behavior of atoms composing the material can be described.

For the present, it must suffice to observe the mutual interdependence of the following phenomena and the depth ratio, which is related mathematically to the energy level and which can be measured in the field with certainty:

1) Cavity growth.
2) The fracture process.
3) Acceleration, displacement, and velocity of the unbroken material.
4) Acceleration, displacement, and velocity of the flyrock.
5) Degree of fragmentation of the broken material.
6) Airblast pressure and noise associated with a blast.

Using the breakage process equation it is possible to calculate: 1) burden, 2) spacing, 3) hole size, 4) weight of charge, 5) depth of subgrade drilling, and 6) height of bench. Blasting practice can then be appraised to determine whether or not it can be improved, and if so how. The calculations can be extended to include the operating cycle and to correlate the unit operations of drilling, blasting, mucking, and haulage. They also provide a means of evaluating methods and equipment, and they facilitate planning future mining operations.

The new technique has not yet been introduced to U. S. mining and construction industries, but recently it has been successfully inaugurated at two large Canadian mining companies.

The following six phases are necessary to successful application of the technique:

1) An appraisal of present drilling and blasting practice and a survey of past practices.
2) An experimental small-scale cratering program to obtain certain blast parameters and the integration of this program with comparable test blasts on an operating scale.
3) Analysis of data obtained from step 2 and blasting calculations leading toward improvement of both drilling and blasting patterns.
4) Introduction of controlled blasting at selected places and appropriate times as part of the normal production schedule. The following factors are considered during this phase:

a) Explosives selection.
b) Delay sequence.
c) Variation in physical and geologic properties of material.
d) Operating cycle.
e) Effect of jointing, fracturing, and alteration of material upon the blasting pattern.
f) Effect of residual stresses and of statically induced stress concentration upon the failure stress.
g) Effect of the newly evolved blasting practices upon slope stability.

5) Training program to acquaint mine supervisors and pit foremen with the principles involved.
6) Periodic inspection of operations to observe features related to the broad general field of rock mechanics.

AT THE 1960 ANNUAL MEETING

The Mining & Exploration Division is presenting four different approaches to achieving better operation: by administration, by instrumentation, through research, through operating ingenuity. (Monday February 15, am)

OPEN PIT MINING

John B. Knaebel and Howard A. Wilmeth, *Chairmen*

Industrial Accident Prevention and Health: *Paul L. Hunter*, Kennecott Copper Corp.

The Use of Digital Computers in the Mining Industry: *Peter B. Nalle* and *L. W. Weeks*, Riverside Cement Co.

Explosions Research Applied to Mine and Quarry Blasting: *Clifton W. Livingston*, Barodynamics, Inc.

Portable Crusher in Open Pits and Quarries Operation: *B. J. Kochanowsky*, Pennsylvania State University

KAISER INDUSTRIES CORP.: PRINCIPLES OF MANAGEMENT

by HENRY J. KAISER JR.

A few months ago I had the honor of addressing the Society of Mining Engineers annual banquet in San Francisco. I have since been asked to amplify some of the remarks I made at that time concerning the management policies of the Kaiser organization and various aspects of our corporate thinking. This is a difficult task for an insider *like myself. I look at the different companies, and the men who run them, and it is hard to think of these men in terms of* policy *or* procedure. *Actually I prefer the term management philosophy to either policy or procedure. My father, Henry J. Kaiser, is not only the founder but the guiding spirit of our organization. His philosophy, and in turn that of the organization, centers around two concepts, service and accomplishment.*

We have never consciously written down or devised a set of rules to govern decision-making practices, or indeed our industrial way of life. We have never had the time to sit down and draw up a policy. Nevertheless, the organization has certain basic characteristics.

A Pattern for Growth: Big though the framework of the Kaiser organization is, I feel it moves quickly when the need arises. One example suffices: in 1946 we entered the aluminum business, yet in 1945 or 1944 our executives had their minds on other things —shipbuilding, steel, cement. Aluminum presented itself suddenly as a great opportunity. We took advantage of this opportunity, and today Kaiser Aluminum is among the top three producers.

We ask ourselves two questions before entering into a new project. First, is it financially practicable? Second, is it a contribution? Will it make something available to more and more people at a better price?

We gear our entire operation to basic raw materials: iron and steel, coal, bauxite, aluminum, gypsum, sand and gravel, cement, limestone, dolomite. These are the building blocks supporting the foundation of our economy. These are the mineral resources—ferrous, nonferrous, and nonmetallic alike—from which all other building and construction must stem.

We also have a passion for self-sufficiency. Experiences in shipbuilding, aluminum, and automobile production have taught us what it is like to depend on others for resources and supplies. Therefore our policy has always been to find and develop raw materials resources and to build up enough reserves to meet demand 20, 30, and 50 years hence.

Another great reason for concentrating so heavily on raw materials is the leverage it gives us in commanding the financial backing necessary to expansion. We have always entered a business under the full realization that we could make a go of it only if our corporation could match the growth of population and acceleration of consumer demand. This of course means sufficient credit base for expansion, which in turn depends in great measure upon raw materials.

HENRY J. KAISER, JR., is Vice President and Director, Kaiser Industries Corp., Oakland, Calif.

Looking at Kaiser Steel, therefore, you have to take into account coal mines at Sunnyside, Utah, and Raton, N. M.; the iron ore mine at Eagle Mountain, Calif.; and limestone in the Cushenbury Valley —as well as the Fontana steel plant itself in Southern California.

Kaiser Aluminum? This entire operation is backed by thousands of acres of bauxite holdings in Jamaica, and the company is constantly searching for additional resources.

Permanente Cement, established in 1939, has plenty of raw material reserves, as has its wholly-owned subsidiary, Kaiser Gypsum, with its principal mine on San Marcos Island off Lower California.

The policy has been the same in all of these companies and their affiliates: 1) raw material development and establishment of good reserves, 2) integration of operation, 3) expansion, 4) further integration, and so on.

How Kaiser Operates: The parent firm,* Kaiser Industries Corp. (formerly Kaiser Motors Corp.) is the managing company for the many other enterprises. In all there are about 60 companies producing about 300 different commodities. Basically there are 13 separate operations within the industrial organization. At the head of each is a president, or general manager and his staff, with the staff organization constructed on a *vertical* line. Interlacing these 13 vertical structures are several basic *horizontal* services, giving a combination vertical-horizontal managerial pattern.

* See boxed item on the opposite page.

Each general manager (who, as far as our chief companies are concerned, is also president) is responsible for the operation of his own company, and only that company. His responsibility extends through the top executive policy-making team (Henry Kaiser, Edgar Kaiser, Eugene Trefethen, and Henry Kaiser, Jr.) to the Board of Directors. Each board of directors is independent and each has independent outside members; as a result, the management of these companies have nothing else to think about but their own operations.

Our presidents and general managers act as independently as most company presidents do. If a man is not permitted to express himself in terms of decisions and responsibilities, and in the risks he takes, then he is not being given the kind of incentive that will make him a first-rate manager.

Horizontal responsibilities that cross-cut the various companies are managed by people who have nothing to think about except their particular specialty. These managers are not responsible to the general managers but report to the overall policy-making group. *Consistency* is the key word here. Even though these companies have individual personalities they are also members of a group or family, and final strength lies in the *philosophy* of business enterprise which all must pursue in unity. Problems in marketing, sales, distribution, research, and transportation must be solved within the structure of each company. But holding these companies together are the broad basic principles that guide us in the fields of labor relations, finance, public relations, and legal and government relations.

Management Philosophy: Through vertical line management with its strong degree of independence and responsibility we achieve speed of operation, incentive, and flexibility. The horizontal checks and balances act as bonds that draw the companies together in a field of common interest, without restricting individual goals and drives.

Top management in each company, and as a whole, functions on the principle of delegating responsibility. Management also strives to make itself readily available for consultation, often easier said than done. The fact that many of Kaiser's business associates call this management system *informal and easygoing* is the best tribute, I feel, to the success of the attempt.

Without communications, up as well as down, without an open-door policy, management can unnecessarily hamstring itself and cut off the life blood of fresh and stimulating ideas that may come to it from without. A closed door is the surest way, in my opinion, to closing oneself off to valuable thinking.

For example, my brother Edgar's office may be visited all in the same morning by Dusty Rhoades, President of Kaiser Aluminum, or Jack Ashby, President of Kaiser Steel, or Wally Marsh, President of our Permanente Cement Co. Each of them may have a different problem, but in the course of the morning, because of this freedom of communication, there may be found a common thread that will aid us in arriving at a solution on a family-wide basis. Often on such occasions, Edgar picks up the telephone (our best and most widely used communicator) and calls our father in The Islands, in order to set up a conference chat between Dusty or Jack or Wally and himself and Dad. Just as often it will be Edgar or I myself who drop into the office of any of our various company presidents with a problem of our own or just to find out what is going on. We try to encourage this same informality throughout each of our companies and among each of the various departments. Without this fluidity

Kaiser management philosophy centers on these ten key points:

Vertical-horizontal structure	**Challenge**
Delegation of responsibility	**Management development**
Open-door consultation	**Communications**
Teamwork	**Incentive**
Individual freedom	**Accomplishment**

of contact you cut off your ability to move quickly and to anticipate situations before they reach crisis proportions.

I like to compare our relations with our executive team to the informality and ease of a fraternity house or club, or any association where one can chat out his ideas and unburden his mind. We don't keep secrets from one another—we share them.

Future Leadership: I seriously believe that one of the most important challenges facing American industry today lies not so much in what we do with raw materials, or marketing situations, but what we do with people—the richest natural resource we have.

In our preoccupation with the logistics of industry, we may be permitting our human equipment to become obsolete. American industry must bestir itself, more than it is now doing, in the development of sound training programs, incentive plans, recruitment programs, and the upgrading of our educational system, so that the bright managers of tomorrow do not become dulled and useless because of our inability to provide them with the friction of challenge and opportunity.

We cannot afford to look upon future management in terms of a stockpile. It is up to us to develop this ore.

Where Kaiser Stands Today: For Kaiser Aluminum the pattern has been one of integration, diversification, and expansion with a mine-to-metal-to-market material flow, from Jamaica on up the Mississippi and Ohio rivers into the heart of 70 pct of the U. S. market. Behind this has been a $700 million outlay and a 474 pct growth in capacity.

Kaiser Steel has had an almost continuous expansion program under way since 1945 and operates one of the most diversified steel plants in the country. Once again, the policy has been clear and consistent: raw materials—plenty of reserves, location in the midst of a growing market, low-cost operations, integration of facilities, and competitive advantage within the industry. Steel, like aluminum, is a growth industry.

As in the case of Kaiser Steel, the success of Permanente Cement and its subsidiary, Kaiser Gypsum, has been due in part to the tremendous population growth in the West. In the seven western states alone population has grown from 5 million in 1950 to almost 22 million in 1958. Again the combination of raw materials reserves, low-cost operation, and ease of delivery to market has made these two companies highly competitive.

In the decade following World War II there has been an overall expansion program in Kaiser Industries amounting to about $1.5 billion. None of this represents government borrowings, and all past government loans have been repaid in full with interest. Support has come from banks, insurance companies, and other institutional investors and investment bankers.

The financial base for the entire industrial organization, with its rapid postwar growth, stems from one basic unit, the Henry J. Kaiser Co., wholly owned subsidiary of Kaiser Industries Corp. This is the oldest Kaiser company. It has three basic operating divisions, the Kaiser Engineers and Heavy Construction divisions and Kaiser Sand and Gravel. The earning power of these three divisions established a basis for credit on which to branch out in other directions. Through good earnings here—in basic buildings and construction—Kaiser secured the experience, know-how, and success for expansion in the postwar decade.

Up to the start of World War II individual and joint-venture projects numbered over 1000 and totaled $383 million, including dams, tunnels, pipelines, and similar construction. Beginning with a cement plant in 1939, Kaiser Engineers extended its services in design and construction of industrial plants and processes to other concerns, as well as to other Kaiser companies, and to the Government. By 1958 Kaiser Engineers and Heavy Construction divisions had an annual work volume of $222 million.

And in a More Personal Vein: It all started with a fellow called Henry J. Kaiser. He built this organization. He is still building it, even though he has passed a great deal of responsibility on to my brother Edgar, the President, to the Executive Vice President Eugene Trefethen, to me and to all the general managers and their staffs.

My father's spirit—his joy of accomplishment—permeates the entire organization. He lives and breathes accomplishment. Challenge to him is life. He says, "Go ahead, run the show. Do the impossible . . . watch how you grow!" This is very much a part of our management philosophy—pass authority on to young executives and watch them grow in meeting the challenge.

In fact if there is a key to anything called a Kaiser Management Policy it lies in the paradoxical fact that there isn't one. There is instead a shared faith and a shared job of accomplishment. This is something you don't write down—you live it every day.

THE KAISER CORPORATE STRUCTURE

The parent firm, Kaiser Industries Corp., is the managing company for the many other enterprises. In all there are about 51 companies and subsidiaries represented by 91 major plants in 19 states and territories and 5 foreign countries. There are 50,000 employes and 80,000 stockholders.

These companies together produce aluminum, cement, gypsum, steel, iron, chemicals, refractories, sand and gravel, electronic systems, guided missile and aircraft components, baththubs and sinks, Jeeps, passenger cars (in Brazil and Argentina), and wood products—about 300 different commodities in all.

Key companies are Kaiser Aluminum & Chemical Corp.; Kaiser Steel Corp.; Permanente Cement Co.; Kaiser Gypsum Co.; Willys Motors Inc.; Henry J. Kaiser Co. and its Kaiser Engineers, Heavy Construction Div., and Sand and Gravel Div.; and Kaiser Metal Products Co.

Educational Requirements and

THE FUTURE OF THE MINERAL INDUSTRIES

Edited by W. C. LACY

The last crop of graduates from our colleges and universities who sought employment in the mineral industries found that they needed to hustle to find a job. There was no longer a list of waiting employers to choose from. Some of them became discouraged and drifted into other fields; many are still looking for employment. Word has gotten around that there are no jobs available in the mineral industries, and enrollment in the various colleges of mines and mineral industries has started to drop. Even established professional men are finding themselves suddenly out of work because of unstable metal prices and rising costs. All these people—students beginning to search for a career, young engineers not yet established—face the same problem: "What is the future of the mineral industries, and what type of training will best qualify the scientist or engineer for this changing field?"

This question was posed to a number of leaders in different phases of the industry. Their comments are summarized as a guide to those considering a career in the finding, extraction, or beneficiation of mineral products.

W. C. LACY is Professor of Geology, College of Mines, University of Arizona, Tucson.

EXPLORATION AND GEOPHYSICS

A. A. Brant—Newmont Exploration Ltd.

This past year makes us realize the extent to which price and economic cut-off may stimulate or curtail exploration. The first question today might be: Do future demands warrant exploration? Over the long term there can be no doubt, in view of the increase in world population and increased consumption per person. This requires active effort to broaden base metal usages as compensation for inroads of other materials. Exploration, therefore, does not consist solely of discovering sources of material. There is just as inspiring and imaginative a territory in the development of applications.

As broader uses of materials arise more minerals will be sought, so our search will broaden, even to the oceans, for the automatic controlled deposition of small amounts of metal present, or for recovery of the deposits, such as manganese, copper, and nickel, on the floor of the southwest Pacific.

We shall develop additional rapid and automatic airborne means for sampling the existing physical forces and chemical traces near the earth's surface, and also largely automatic, i.e., computer means, for systematically evaluating and correlating these measurements with conditions within the crust. Improved measurements and corrective processes will carry our mineral search deeper into the earth's crust where even today broad seismic and electrical measurements reach to the Moho phase discontinuity and beyond.

Geologically we shall acquire more and more detailed knowledge of the physical and chemical forces present and reacting in this exquisitely balanced, cyclic earth of ours. We hope to be able to predict the conditions and sequences that lead to mineral deposition, where today we merely presume.

An educational pattern, therefore, should seek to develop imagination and thinking beyond the existing. This is the reason for the study of mathematical formulas, physical forces, and chemical re-

actions—not as an end in themselves, but as the tools that might permit that one extra step over the brink of tomorrow.

If a man is to build he must have bricks or stones, mortar, and wood. If he is to explore the universe, he must have a working knowledge of physics, mathematics, chemistry, geology, and astronomy. Nature does not generally unlock her secrets to approximations and guesses. Effort, care, and persistence are necessary; discouragement and failure are frequent. Man must acquire the tools to put thought or imagination into some comprehensive form, in short, the scientific language of his particular realm of endeavor.

It may be asked whether we have tried to make our education too easy, not in quantity of work, for most students work hard, but in the difficulty and nature of material presented, and in the rate of flow. Have we not overstressed social education at the expense of solid science? Could not a large part of the first two years of college be compressed into high school, and could not university work be carried to a higher level?

One more factor in the educational field should be illuminated—the fixation, at high school level, that the grandiose educational plants assure a high degree of education irrespective of the teachers. The order of importance should be reversed. Are not inspiration and discovery first stirred by the teacher and the interest and imagination he can generate? A good teacher can do it, and frequently has, in history, without even a roof.

INDUSTRIAL MINERALS

F. C. Kruger—International Minerals and Chemical Co.

Our problems in industrial minerals are many, yet perhaps no more than in the mining industry as a whole. This is the youngest, most immature segment of the industry; consequently the opportunities in this field have not been recognized by those who deal with mining and investment. Industrial minerals have lacked the glamor of the recent uranium boom or the famous gold and silver strikes. This may be because the deposits are often small and the commodities almost always low in value. Many industrial mineral deposits are of the follow-your-nose variety, ubiquitous, there for the taking. Still others are chance finds. A large number have been stumbled upon and developed by curious amateurs. Very few are scientifically sought.

Marketing information—prices, specifications, producers, consumers—is often scant and even sometimes tightly withheld. For many of the nonmetallic commodities, standards of quality are not widely recognized or accepted. In some instances specifications apply to one particular deposit and thus a market may be built around an individual discovery.

Vexing problems are encountered in upgrading the industrial minerals. The methods in most common use have been selective mining, hand cobbing and picking, screening and washing, jigging, tabling, heavy media, and flotation. Often the ranking of their success has been in this same order— the large-tonnage, low-cost methods of concentration have not been altogether successful because of the economics.

What are the opportunities? We have said that the industrial minerals may be found in almost every rock type and occur almost everywhere. This in itself is opportunity. Opportunities may be found in new and unsuspected sources, new and unsuspected uses, new and unsuspected byproducts. Likewise there is much opportunity for research on concentration of minerals by conventional methods as well as new ones. As a generalization, the industrial minerals offer opportunities because the capital requirements are small, the markets are growing, the competition is less intense, and the prices are steady.

Our profession needs good men, well-rounded men. We need more than just geologists. The industrial minerals are widely distributed geologically as well as geographically. The geologist who would tackle these minerals must have broad experience with all kinds of deposits. Grounding in geology and mineralogy, understanding of economics, familiarity with mining and metallurgy, knowledge of the present and possible uses of mineral commodities—he needs all these and more. His course work should stress observation and deduction and therefore emphasize field geology. All this adds up to an emphatic *thumbs down on specialization*. If a young man is cast in the mold of petrographer, micro-paleontologist, assayer, geochemist, or other narrow specialists of these *bread-and-butter* courses, it will probably help him to get his first job out of college. But what about five or ten years out of school when his advancement will depend upon wider abilities in which he should have had earlier training? For example, a geologist looking for bauxite can conceivably apply paleogeography, physiography, mineralogy, economics, metallurgy, and structural geology, and all in the same drillhole! On other assignments for the same company, the same geologist will probably be looking for acid-grade fluorspar, chemical-grade limestone, plant water supply, and so on throughout his career. To prepare for this, what kind of specialist should he be?

The young graduate entering the professional level usually has much to learn. He finds that a grade of 75 pct may have been passing in school, but it is far from satisfactory performance in industry. The newly graduated man would be lucky to get into an organization like Cerro de Pasco, or Anaconda, to name two companies with long traditions of training geologists and mining engineers. The advantages for learning in such a set-up are obvious, and the experience is second to none. He should not overlook the many advantages in *going foreign*, at least early in his career. An unbelievable amount of experience can be crowded into a few years. Responsibility that

would not come for years on a domestic job is virtually thrust upon the young engineer on a foreign job, and with it come the real opportunities to learn and advance in the profession.

There is always room for self-improvement. After graduation, sooner or later, the thoughtful man will come to a period of critical self-appraisal in which he will wonder, "Am I really cut out for this work?" If he is honest, he will find large areas for self-improvement. This can be accomplished by a personal reading program, particularly in the humanities, or by adult education classes, or by attendance in one of the many business management courses, or perhaps by cultivating hobbies related to the profession. Each man should take time occasionally to take stock of his own philosophy, his integrity, creativity, and industry. Each must *know what he knows and must do what he knows.*

It is popular to blame poor report writing on the recent graduates, but even some of the profession's highest-priced consultants are so adept at evasive reporting that the investment and business fraternity tends to discount, or worse, disregard their reports. We cannot afford this continuing but deserved depreciation of the reputation of our reporting. We must be tireless in sharpening the focus of our observation, enlarging our field of experimentation and improving our recording and mapping, so that we can become definite in our deductions and positive in our reporting.

MINERALS BENEFICIATION

Norman Weiss—American Smelting & Refining Co.

Decisive developments in minerals beneficiation in recent years may be classified as: 1) new techniques and processes, 2) the extension of older processes to new types of ores, and 3) improvement of costs.

The first category is reflected in the full-blown technology of uranium-ore milling with increasing employment of ion-exchange resins and solvent extraction. The saving of gold, silver, and cyanide by ion exchange in the cyanidation process shows possibilities, while from the desalting of water we are borrowing the application of osmosis theory by using semi-permeable exchange membranes to separate metals in solution. Direct hydrogen reduction, as used in the Sherritt-Gordon process for removing nickel, cobalt, copper, and perhaps other metals from solutions offers further possibilities. *Foam fractionation* and *zone refining* are two more expressions in the growing lexicon of beneficiation terms.

Flotation, for many years the work-horse process of milling, is moving confidently into new areas. Mineral phosphates, tungstates, salines, fluorite, barite, quartz and some silicates, heavy minerals from beach sands, oxidized ores, iron ores, and coal are only a few of the natural minerals that are now separated and concentrated by froth flotation. Reagentizing, or agglomeration by surface-active reagents, is in practical application on phosphate sands.

In those base metal mills where flotation became established 20 years ago improvement has been generally continuous, but in most cases there is still room for improvement. Every operation along the way—crushing, storing, grinding, classifying, thickening, pumping, and conditioning—contributes to the constantly improving quality of base metal separations. While new reagents have been few, there have been such outstanding advancements as the soluble glycol ether frothers and the use of oxidizing agents in molybdenite separations. The high molecular weight polymers now in wide use for flocculating suspended solids, though not strictly flotation reagents, have had indirect influence.

Recent literature is replete with innovations in the flotation of nonsulfide ores, and the main reason is that the process is not wholly acceptable—it does not do the whole job—on ores of this type, and consequently there is more field for discovery and improvement.

Gravity concentration has also made excellent progress in the last decade—to mention the Humphreys spiral, Cannon concentrator, and the Remer jig. Heavy-media separation has gained wider acceptance and greater sophistication. Improvements in magnetic separations, both dry and wet, and high-tension concentration have good prospects for further advancement. Possibilities of crushing ore by tensile failure induced by high-frequency electromagnetic induction demonstrates that the evolution from new knowledge to application can occur overnight.

Automatic control has manifested substantial gains in the postwar period, aided by progress in the fields of nucleonics and electronics. Nearly every step of the milling operation, from crushing to tailing disposal, is now self-controllable or controllable from centrally located consoles with feedback information. The sophistication of these systems is increasing daily, and the use of electronic computers to make and execute decisions or choose alternative programs is not far off. Process control, both *in-process* and quality, both environmental and analytical, has resulted in better metallurgical efficiency and more economies in labor.

The greater use of data-reduction equipment and statistical methods is a logical corollary to our increasing capability in the field of identifying and measuring process variables. It is imperative that our capacity to correlate these data keep pace with the means of accumulating them, else we shall merely be transferring men out of the mill into the mill office. All of this calls for good judgment on the part of management, because costs and expected gains have to be carefully equated.

The foregoing catalog of progress is only in part a record of accomplishments and in part one of plans and hopes for the future. We must not only drive toward present objectives, but keep mapping future targets as new knowledge is discovered and becomes

systematized. The brains and the hands for these momentous tasks must be trained by our colleges, and therein lie some problems.

The writer has reviewed the undergraduate minerals beneficiation curricula of four of the leading mining schools in this country and has also received impressions and opinions from their faculties. Trends are unmistakably toward better education in the basic sciences, more hours in the humanities, greater flexibility in professional subjects, and more emphasis upon learning to test, apply, and evolve new concepts rather than learn manual skills. However, educators recognize the existence of two basic and opposite schools of thought and find difficulty in either choosing or compromising between these attitudes.

One group believes that traditional curricula are obsolete, that the engineering student is not prepared to contribute to new areas of knowledge, and that he must have more training in physics, chemistry, and mathematics. The supporters of this position claim that the whole scientific and engineering field is advancing at such an accelerating pace that it is unrealistic to hope that the practice we teach the student now will mean anything to him in a few years. True fundamentals of his profession will be of lasting value and will give him freedom to choose among Research, Development, Design, or Industrial Management as a career. Without doubt, this school of thought would shape the undergraduate curriculum toward graduate school and scientific research, providing as early as possible the philosophical environment that is favorable to such a career.

The other school raises serious objections to this line of thought, believing that the function of the engineer differs profoundly from that of the scientist, calling as it does for a variety of judgments and decisions foreign to the scientist's interests. The two chief concerns of the engineer are *cost* and *reliability*, and these modes of thinking must be instilled in the student at the earliest possible stage of his development.

In applying these considerations to the specific problem of educating the minerals beneficiation engineer, we are safe in saying that we need both kinds of individual: the science-minded student who will probably go on to graduate school and make applied research and development his life work, and the industry builder who may or may not go on to graduate school. The puzzle that faces the educators is whether to build a single curriculum in minerals beneficiation that suits both needs or to offer parallel options in the curriculum. Neither is satisfactory.

This dilemma has been handled in two of the colleges reviewed by the offer of electives in professional subjects in the junior and senior years. The first two years follow a common pre-engineering course with emphasis on physics, chemistry, and mathematics and attention also to the humanities. In the upper division the student elects his professional courses under careful guidance. At this point, presumably, the student chooses between science and engineering, and among various metallurgical options, including minerals beneficiation.

In the other two colleges reviewed the curricula were found less flexible. The student chooses his future field after the sophomore year, then takes all the required subjects, which must therefore include courses of both kinds. It is typical of this type of curriculum that the student finds little or no time for courses in management or the humanities, but on the other hand is exposed to the maximum total volume of technical knowledge and application of fundamentals.

Both of these are compromises, especially in the case of the research-oriented student, because there is lacking the essential contact with new activities in related disciplines. Minerals beneficiation is no longer an activity complete in itself; it contains areas in common with other scientific and engineering fields. If we are to keep our industry vigorous and lively, these new areas must become known to the undergraduate who may wish to explore them in his graduate work, and later in industry.

Perhaps we need a curriculum in metallurgical science, comprising a more thorough grounding in basic sciences than is needed by the engineer, several fundamental courses in metallurgy, a suitable proportion of electives in the humanities, and in the upper classes a number of parallel options, such as physical metallurgy, extractive metallurgy, ceramics, and minerals beneficiation. This program would lead directly into applied research, preferably by way of graduate school.

In the same way, metallurgical engineering, of which minerals beneficiation is a subdivision, can no longer be considered a distinct subject. Old divisions of civil, electrical, mechanical, chemical, mining, and metallurgical engineering have become less distinct, and more of the engineering curricula should be changed to accommodate this concept. Given a clear choice between *metallurgical science* and *metallurgical engineering* the undergraduate might receive a broader education without losing the advantages of specialization.

Great advances will always come from the brilliant discoveries of a few men, and these men of the future will come to maturity only in the graduate school, then go on to join the staffs of the colleges, or industrial and government laboratories, and become the scholars and intellectual leaders in every field.

For the most part there has not been sufficient development of high-quality graduate work and research in engineering. Two primary requirements are needed to bring about an excellent graduate division—money and talent. Money is needed for adequate buildings and equipment; for scholarships, fellowships and research contracts for graduate students; and for enough additional compensation to faculty and research leaders so top-grade men can stay without personal sacrifice.

Our Federal Government is taking upon itself much of the responsibility for improving and increasing educational facilities in the fields of science and engineering, but this does not relieve industry of its obligations.

Scholars of first rank are needed to lead and inspire the younger men. Too many brilliant scientists and engineers are being attracted into industrial and governmental laboratories, when it is obvious that some of these men should be teachers and leaders. Granted that industry is short of such people—there will be an even greater shortage if we do not retain some of them in the colleges.

It will accomplish little good for industry to appropriate large amounts of money for industrial research if the link between new knowledge and new applications is too weak to carry the load. That link is the graduate school.

Paley Report Series — No. 4

CURRENT TREND OF PRODUCTION AND CONSUMPTION OF SOURCES OF ENERGY

by EUGENE AYRES

This study is concerned primarily with a backward look at the projections made in the *Report to the President by the President's Materials Policy Commission* issued in June 1952. Only a few years have elapsed since the date of this report, but definite statistics available then were often not later than 1947. Today we have figures for the intervening years through 1957—virtually a ten-year span. What, if anything, has happened during this decade that was unexpected or wrongly appraised? In the light of more recent data and trends, will we be justified in modifying the longer-term predictions made in 1952? This study will attempt to answer such questions. Major sources and forms of energy will be considered from the standpoints of ultimately available amounts and the rates of production and demand.

Electricity: The PMPC projections were made on the basis of an unexpected growth of about 10 pct per year. This was at a time when some experts in the field were assuming growth rates of not more than 8 pct. It happens that the actual growth for the ten years has far exceeded the PMPC estimates:

Year	Billions of Kilowatt-Hours	
	PMPC	Actual
1950	389	389
1955	617	629
1957	685	716

On the other hand, the PMPC estimates of the portion of electricity to be generated by hydropower were too high:

Year	Billions of Kilowatt-Hours	
	PMPC	Actual
1950	100	100
1955	150	116
1957	163	133

Expressed as a percentage of the total the figures are as follows:

Year	Hydropower	
	PMPC, Pct	Actual, Pct
1950	33	26
1955	24	19
1957	24	19

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The two deviations taken together indicate that since demand is rising more rapidly than expected and hydropower is taking a lower proportion of the load than expected, the demand for fuel is rising much more rapidly than expected. If the projection is made in a straight line from current trends, the electric power demand in 1975 may be about 1600 billion kw-hr instead of the PMPC figure of 1400, and of this approximately 1360 would have to be thermally generated instead of the PMPC figure of 1100 which, they remark, might well be too low.

One of the most interesting consequences of our rapid expansion in demand for electricity has been pointed out by E. H. Krieg of Stone and Webster. Our largest steam-electric generating plant, if doubled every two years, would reach 16 billion kw about 1990. This would require a plant site of nearly a square mile and would consume the coal from eighty 70-ton cars an hour, and the prodigious amounts of cooling water required could be obtained only on the seacoasts, the Great Lakes, and major rivers. Nuclear fuels would eliminate the coal supply problem but not the plant area and cooling water problems.

Coal: PMPC remarked that coal gave 49 pct of our energy supply in 1947 but that if oil and gas are in adequate supply coal can be expected to decline in relative importance, "perhaps reaching 33 percent by 1975." In the decade since 1947 U.S. consumption of oil and gas has increased 37 and 77 pct respectively, while consumption of coal has actually declined a little. The low relative contribution of coal predicted for 1975 has already been reached and will go somewhat lower. But the relative upturn in coal may begin before 1965 instead of after 1975 as predicted. Some of the reasons for this will be outlined in the paragraphs dealing with oil and gas, but a primary reason is the phenomenal rate of growth of demand for electric power and the fact that coal is likely to remain the prime fuel for generation. Since 1954 about 30 pct of the coal consumed in the U.S. has been for electric power generation. In 1947 the proportion was only 14 pct. In absolute terms when the PMPC report was written, 90 million tons a year of coal was used for electric power generation. In ten years the figure has almost doubled. If the PMPC prediction of 1400 billion kw-hr generation in 1975 is correct, 590 million tons of coal would be required in that year for generation. This is based on an average thermal

requirement of 11,000 Btu per kw-hr and assumes no hydropower. Since thermal power is likely to comprise at least 85 pct of the total in 1975, coal requirements would figure about 500 million tons. The plausibly higher generation of 1600 billion kw-hr would require 570 million tons of coal per year. This is far more than the total amount of coal now being mined, and it cannot be assumed that all other uses for coal will disappear.

In 1956 it was estimated[1] that we have something like 27 billion tons of bituminous coal of present quality that can be mined at something like present costs. This is in substantial agreement with the earlier PMPC estimate of 30 billion tons. According to this, peak of production of such coal should be reached about 1970 and increasing proportions of coal thereafter should be cheap coal of poorer quality and good coal at higher cost. Such a date assumes that the demand for coal will have risen by 1970 to about 700 million tons per year—a total somewhat lower than the sum of 570 million tons for generation and the nearly 200 million tons projected by PMPC for general industrial use for 1975. This coal projection is in substantial agreement with that of *Resources for the Future*.[2]

PMPC points out that the Free World depends largely on the U.S. for coal reserves. This fact is important because the demand of the Free World outside the U.S. for electric power is growing much more rapidly than ours. During the past decade our coal exports have averaged 53 million tons per year. Our exports can be expected to grow rapidly over the next decades.

All these projections assume that thermal power generated by fission of nuclear fuels will not be a factor, whether because of competitive cost or because of the nagging doubt that such nuclear energy represents *net* energy. We do know that in the present state of the art many thousands of times as much energy is required to accomplish *fusion* as is generated by fusion. And we know that the AEC in manufacture and maintenance of fissionable elements is currently consuming more than 50 billion kw-hr per year. But if the energy of fission can add anything to the world's energy pool, nuclear power will eventually make radical changes for the better in our energy prospects, and if invention can change the fusion plan from a very large negative to even a small positive energy increment the future of energy supply will be secure. And no one can say that some new easier ways of capturing nuclear energy may not be discovered. The PMPC report was prepared much too soon to take nuclear energy into serious account. It is still too soon.

Oil: PMPC concludes that "it should be possible with the resources at its command, supplemented by imports of petroleum and perhaps some natural gas, to keep supply [of petroleum] in step with expanding demand from now to 1975." The important qualification here is "imports." The report recommends expansion of imports of petroleum and remarks: "In view of its future needs and limited resources, this Nation should welcome crude oil imports, not place obstacles in their way." Nothing that has happened during the past decade suggests a change in this recommendation.

The PMPC report was reasonably accurate in projecting U. S. domestic demand over the past decade, except that *total* U. S. demand has been increased each year by the 5 or 6 pct we have exported. Production of crude oil plus natural gas liquids has exceeded the maximum rate projected by PMPC. (The natural gas liquids ran nearly 14 pct of the crude in 1957.) The crude oil alone ran below the minimum PMPC projection.

No new figures on estimated totals of oil reserves yet to be discovered are available. Hence it is too early to know whether the 1965 estimated peak of production of crude oil still holds. No good geological reason has appeared to change this estimate, although speculation has been rife. *Resources for the Future* has assumed that 500 billion bbl of oil might ultimately be produced in the U. S. and its continental shelf. This is about six times as much as conservative petroleum geologists are now willing to predict. Of the 500 billion, 200 billion "consists of discovered resources which cannot be recovered by current techniques and at current costs and prices," and the other 300 billion includes "great quantities of resources which are, as yet, undiscovered." We may hope, of course, that these figures will be realized or exceeded, but the U. S. cannot base its policies for survival on hope.

The curves for supply and demand have been diverging over the past ten years, and in 1957 U. S. production of crude oil plus natural gas liquids was only 85 pct of U. S. demand. PMPC points out that to keep pace in the U. S., even with proportionate imports, new discoveries and developments must "run about 1.4 times annual production." The figures for increments in reserves for the past decade are highly variable, ranging from about nine times annual production in 1951 to an apparent shrinkage in reserves in 1957, but the average for the decade shows the increment in reserves to have been about 3.4 times average annual production. The U. S. is more than holding its own in this respect. But this throws no real light on the problem of peak of production. If all future reserves were discovered at once, we could pinpoint the date of peak of production with some certainty. But the immediate discovery in itself would not bring the peak closer or put it farther away than the present irregularly gradual discovery.

It is well understood that demand in the U. S. is climbing much more slowly than demand in the rest of the world, because we are climbing from a much higher base. The figures from 1950 to 1957 are striking in this respect. In 1950 North American demand (96 pct ours) was nearly twice the demand of the rest of the world, while in 1957 the demands were nearly equal. During this period our demand increased 40 pct while the U.S.S.R. demand increased 153 pct. European demand west of the Iron Curtain increased 117 pct. South American demands increased 70 pct. This means, of course, an ever greater competition for world oil.

The PMPC long-term projections seem to have been on the low side for demand both for the U.S. and for the Free World. The PMPC straight line projections to 1975 showed 13.5 million bbl a day for the U.S. and 27 million for the Free World. Similar lines drawn through the actual 1957 points show about 17 million bbl a day for the U.S. and 33 million for the Free Word. Future demand figures may not, of course, lie in a straight line but may turn down or up as time goes on. But it seems probable now that U.S. demand in 1975 will be more than double U.S. production, and that the rest of

the Free World will be dependent largely upon Middle East production. If this comes to pass we may expect the use of oil to be almost exclusively limited to internal combustion and other similar unique applications. For mere Btu's, coal will be preferred.

PMPC lays little stress on shale oil or conversion of coal to liquid. This seems wise in view of the present indications that the rate of shale oil production by 1975 can be relatively slight and that we do not have enough reserves of cheap coal of suitable quality to justify any considerable coal conversion. These two sources of liquid fuel may be almost neglected in projections. The problem for the U. S. (and the world) is to find a substitute for internal combustion for automotive transportation. Perhaps the Lockheed fuel cell will make it possible to give electric motor cars the necessary power and distance, or perhaps our inventors will come up with an adequate storage battery. The solution of the problem of future transportation on the surface of the earth is of enormously greater importance than the problem of space travel.

Natural Gas: The PMPC projection for U.S. demand for natural gas was definitely too low—8.7 trillion cu ft for 1957 as compared with 10.7 trillion actual demand. Gas is such a convenient and desirable fuel for stationary heat and power applications, and its cost is so relatively reasonable, that demand over the next decade or so would probably rise as rapidly as pipelines could be provided for distribution. Additional pipelines, however, will be built only if return on investment seems attractive and secure. It was estimated in 1956[1] that if gas production should increase at the rate of 4 pct a year (the PMPC assumed rate) and if the U.S. has not more than 600 trillion cu ft of proved plus unproved gas reserves (a figure somewhat higher than the PMPC estimate), the peak of U.S. natural gas production should come before 1970 and the maximum rate at the peak would be about 13 trillion cu ft. No evidence has appeared to justify the assumption of higher reserves of gas, and the actual rate of increase in consumption since the PMPC report has averaged better than 10 pct a year. If they have any confidence in apparent trends, entrepreneurs may not feel justified in building any more major pipelines except, perhaps, for such special cases as entry of Canadian gas. This gas reserve, by the way, is believed to amount to some 10 pct of U.S. reserves, about enough to satisfy U.S. demand for two or three years. We are consuming gas now at the fantastic rate of about 1.25 billion cu ft per hr.

Resources for the Future,[2] in the case of gas as well as oil, prefers higher figures for reserves. Rather empirically it doubles the 600 trillion estimated by geologists. If 1200 trillion happens to be correct, the peak of gas production would be postponed about ten years. The major effect would be the height of the peak which might go as high as 17 trillion. Even this, however, is below the 20 trillion projected by RFF for 1975.

An increasing proportion of gas is that associated with oil production. PMPC estimated that continued U.S. oil production of 2 billion bbl of crude oil a year should eventually provide a net gas production of 12 trillion cu ft of gas. This overall ratio of oil to gas has not yet been reached. U. S. oil production now exceeds 2 billion bbl, and of the gas production of approximately 10 trillion, about 6 trillion is form reserves of non-associated gas, discovered several decades ago.

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[2] *Resources for the Future*: Annual Report, 1958.

AT THE 1960 ANNUAL MEETING...

The Council of Economics is presenting a session on Fuel Economics (Monday, February 15, pm).

FUEL ECONOMICS

Warren B. Davis and George A. Lamb, *Chairmen*

A Method of Projecting U. S. Petroleum Supply: *Paul W. McGann*, U. S. Bureau of Mines

A New Performance Measure to Test the Contribution of the Petroleum and Natural Gas Industry in an Expanding Economy: *Virgil L. Barr*, U. S. Bureau of Mines

The Question of Governmental Oil Import Restrictions: *Wm. H. Peterson*, New York University

Trends in Property Acquisitions and Mergers in the Oil Industry Since 1954: *H. Marshall Farrier*, Continental Oil Company

Bituminous Coal Consumption—Estimating its Long Term Growth and Annual Variation: *W. Gibson Jaworek, J. J. Schanz, Jr.*, Pennsylvania State University

THICKENING LEACH RESIDUES IN SHERRITT GORDON'S NICKEL REFINERY

by D. J. I. EVANS and S. C. LINDSAY

With each year that passes hydrometallurgical processes are being more widely used to recover base metals from ores and concentrates. Generally these processes involve liquid-solid separation of metal-bearing liquors from barren residues. This may be done by countercurrent decantation, thickening and filtration, or filtration or centrifuging only. Choice of method is governed by chemical and physical characteristics of the pulps; cost of labor, power, materials, and waste disposal; and even by the amount of capital available when building plans are under way. Since all these controlling factors change with time and location and with technological advances, the separation method must be re-evaluated when new plants or expansion programs are contemplated.

At the Sherritt Gordon refinery in Fort Saskatchewan, Alberta, an ammonia pressure leaching process recovers nickel, copper, and cobalt from the nickel concentrate produced at Lynn Lake, Manitoba.[1] Pregnant liquors are separated from the barren leach residues in a thickener-filter liquid-solids circuit. The decision to use this type of separation was based on a summation of economic factors during the pilot plant and design stages. Although countercurrent decantation was not incorporated in the refinery flowsheet, the problems solved in thickening the leach residues and the experience gained in operating the commercial plant are pertinent to countercurrent decantation, particularly where it is applied to slow-settling leach slurries or slurries having a relatively high vapor pressure of a valuable, obnoxious, or poisonous vapor.

The nickel sulfide concentrate is leached under pressure with air and ammonia to dissolve the nickel, copper, and cobalt and most of the sulfur, leaving a residue of iron and siliceous material to be discarded.[2,3] During a subsequent distillation stage to recirculate part of the ammonia used for leaching, copper is recovered from the solution as a high-grade sulfide. After further purification to remove traces of copper and undesirable sulfur compounds, the nickel is precipitated by hydrogen under pressure at an elevated temperature. The cobalt, together with unreduced nickel, is precipitated as a mixed metal sulfide by hydrogen sulfide for eventual cobalt recovery. The end solution is then evaporated to produce a crystalline ammonium sulfate byproduct.

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As shown in Fig. 1, the nickel concentrate is leached in a continuous, two-stage, countercurrent circuit. In the first stage, or *adjustment* leach, the fresh concentrate is partially leached (60 pct) in the liquor produced in the second stage, or final leach. This system is necessary to produce a solution suitable for treatment in the copper sulfide precipitation step.

Both stages are carried out at 170° to 180°F under a total pressure, with air, of 100 to 120 psig in large, horizontal, water-cooled autoclaves. The autoclaves are divided by overflow weirs into four compartments to give a certain amount of staging during leaching. In each compartment a relatively slow-speed (100 to 150 rpm) agitator maintains the nickel concentrate in suspension. Adjustment leaching, carried out in two autoclaves in parallel, is followed by a thickener-filter liquid-solids separation. Final leaching is done in two parallel trains of three autoclaves using aqueous ammonia to extract metal values from the adjustment leach residues. This too is followed by a thickener-filter circuit. Here the residues are repulped once with aqueous ammonia and twice with process water and refiltered after each repulping stage, to insure a maximum recovery of soluble metal, before being discarded to the tailings pond.

The adjustment leach is followed by a seven-disk Dorr-Oliver American filter, with an agitator in the filter boot to keep the residues in suspension. Agitators have also been installed beneath the four ten-disk filters following the final leach thickener.

Slurry Characteristics: A typical analysis of the Lynn Lake nickel concentrate, produced by differential flotation,[4] is given in Table I. The concentrate comprises 35 to 49 pct pentlandite, (Fe, Ni)S; 3 to 6 pct chalcopyrite, $CuFeS_2$; 1 to 4 pct pyrite, FeS_2; and 24 to 42 pct pyrrhotite, $Fe_{1-x}S$ (where x varies between 0 and 0.2) together with various siliceous minerals such as actinolite, hornblende, and talc.

During leaching, the sulfur in the pentlandite, chalcopyrite, and part of the pyrrhotite is successively oxidized through the thiosulfate and polythionate radicals to sulfate and sulfamate.[5] Simultaneously the nickel, copper, and cobalt are converted to soluble ammine complexes and the iron in the pentlandite, chalcopyrite, and part of the pyrrhotite is oxidized to a spongy hydrated iron oxide. The hydrated iron oxide is readily broken down by the agitation needed to sustain the concentrate in suspension and to maintain a satisfactory mass transfer of the oxygen from the air to the slurry. Table I shows typical chemical, screen, and

Table I. Nickel Concentrate, Adjustment and Final Leach Residues, Chemical Analyses and Physical Characteristics

	Nickel Concentrates, Pct	Adjustment Leach Residues, Pct	Final Leach Residues, Pct
Chemical Analysis, 1956 Averages, Pct			
Ni	13.23	6.04	1.26
Co	0.40	0.31	0.27
Cu	1.79	0.82	0.17
Fe	36.17	41.57	45.86
S	29.47	20.38	12.16
FeO (in the nitric acid insolubles), MgO, CaO, SiO_2, and water of hydration in gangue minerals.	Balance	Balance	Balance
Oxygen in iron oxides.	Nil	—	—
Calculated Mineralogical Compositions			
Pentlandite, (Fe, Ni)S, assumed FeS·NiS with partial replacement of Ni by Co	41.49	19.21	2.30
Chalcopyrite, $CuFeS_2$	5.19	2.38	0.49
Pyrrhotite, $Fe_{1-x}S$, assumed FeS	32.73	32.40	27.54
Pyrite, FeS_2	1.65	1.90 (Assumed)	2.10 (Assumed)
Ferric oxide, Fe_2O_3, (water of hydration not included)	Nil (Assumed)	18.92	37.90
Ni and Co adsorbed on hydrated ferric oxide	—	Not determined	0.77
Actinolite, hornblende, talc, other siliceous gangue minerals and water of hydration	Balance	Balance	Balance
Screen Analyses, Typical			
+ 65 Mesh Tyler	2.8	0.3	0.2
−65 + 100	6.7	2.3	0.7
−100 + 150	10.4	6.4	3.5
−150 + 200	6.3	8.9	5.0
−200 + 325	24.2	12.9	11.9
−325	49.6	69.2	78.7
Subsieve Size Analysis on −325 Mesh Fraction Reported as Percent Weight of Total Solids			
−325 mesh + 35μ	33.6	32.2	17.7
−35μ + 20	4.2	7.7	8.8
−20 + 10	5.1	8.6	9.7
−10 + 5	4.7	8.1	8.3
−5	2.0	12.6	33.2
Average specific gravity of solids	3.68	3.48	3.41

subsieve size analyses (as determined by beaker decantation)[5] of leach residues from the two stages. There is a marked reduction in average particle size and a marked increase in the proportion of hydrated iron oxides as leaching progresses.

Slurry fed to the adjustment thickener is 20 to 25 pct solids, by weight, in a highly ammoniacal liquor (pH 10) cooled to 90°F in a double-pipe cooler before the leaching pressure is released. In addition to about 40 gpl unbound ammonia,* the solution contains about 55 gpl of the valuable metals as nickel, copper, and cobalt ammine complexes, ammonium sulfate and sulfamate, and small (but important) quantities of polythionate and thiosulfate radicals, giving a total electrolyte concentration of about 600 gpl. Specific gravity of the solution is 1.20 and the ammonia vapor pressure of the solution at 90°F is approximately 1.1 psi, which corresponds to a vapor containing 8.0 pct ammonia by volume.

* The unbound ammonia is a calculated figure and is that part of the acid-titratable ammonia which is not locked up in the ammine complexes.

The slurry passing to the final thickener from the second stage of leaching is about 20 pct solids by weight and is cooled to 90°F prior to pressure release and thickening. In this instance the solution contains about 55 gpl unbound ammonia and about 25 gpl nickel, copper, and cobalt as complex amines. The ammonium sulfate and sulfamate concentrations are about one half of those in the adjustment leach solution, but neither polythionate nor thiosulfate radicals are present; the total electrolyte concentration is about 400 gpl. Specific gravity of the final leach solution is about 1.11 and the ammonia vapor pressure at 90°F is 1.5 psi, which corresponds to a vapor containing 11.0 pct ammonia by volume.

Thickener Design: The two thickeners were installed in the leach circuit to separate the bulk of the pregnant liquors from the partially leached and completely leached residues, respectively, and to thicken the pulps enough to give good filtration characteristics. In the original flowsheet, vacuum drum-clarifiers were installed for the adjustment thickener overflow solution to prevent iron oxide slimes from being carried over into the subsequent process stages. Clarifiers were considered unnecessary, as it was assumed that any slimes on the final thickener overflow would be removed in their next pass through the liquid-solids separation circuit. During the first few months of operation, the quantity of slimes overflowing periodically from the adjustment thickener was more than the clarifiers could handle. Improved thickener operation during the start-up period improved the filtration characteristics of the thickener underflows, obviated the need for clarifying the adjustment thickener overflow and made it possible to use the thickeners for surge solution storage.

The completely enclosed Hardinge Co. thickeners, 105 ft ID, have 8-ft sidewalls and 15-ft center depths. The tanks and domes are of reinforced concrete lined with a pyroflex membrane and acid brick. The superstructure and rakes are of 304 stainless steel with Hardinge-type CFAR 2-hp motor drives geared to give rake speeds of 3 rev per hr. Thickener drives and underflow pumps are tied into the refinery emergency power system to prevent sanding up if the main power supply fails.

To prevent air pollution, the thickeners are maintained under slight suction from the leach plant ventilating system. The ammonia in the vapors, together with that from the other tanks and filters in the leach plant, is recovered by scrubbing the vent gases in a bubble-cap tower. Although the thickeners are outside, ammonia pollution of the atmosphere must be prevented because the towers for the refinery's water-cooling circuit are nearby.

Placing the tanks below ground level avoided the costly structure necessary to support the thickener and its 540,000 gal of slurry and made it possible to use cheaper construction materials, but these advantages are somewhat offset by less convenient operation. The pumping stations are presently 7½ ft below the top of the straightwall, and the shaft drops down 22½ ft to the tunnel leading to the thickener cone. As there is no satisfactory means of drainage, leaks and spillages into the tunnel are safety hazards. It is compulsory that anyone entering the tunnel wear an ammonia mask and be attended by someone else.

START-UP PROBLEMS

Sliming: During the start-up period satisfactory continuous operation of the liquid-solids circuit was maintained for a few days, even though the slow-settling pulp was discharged into the final thickener. The sands were satisfactorily discharged from the thickener, but the slimes level gradually rose and

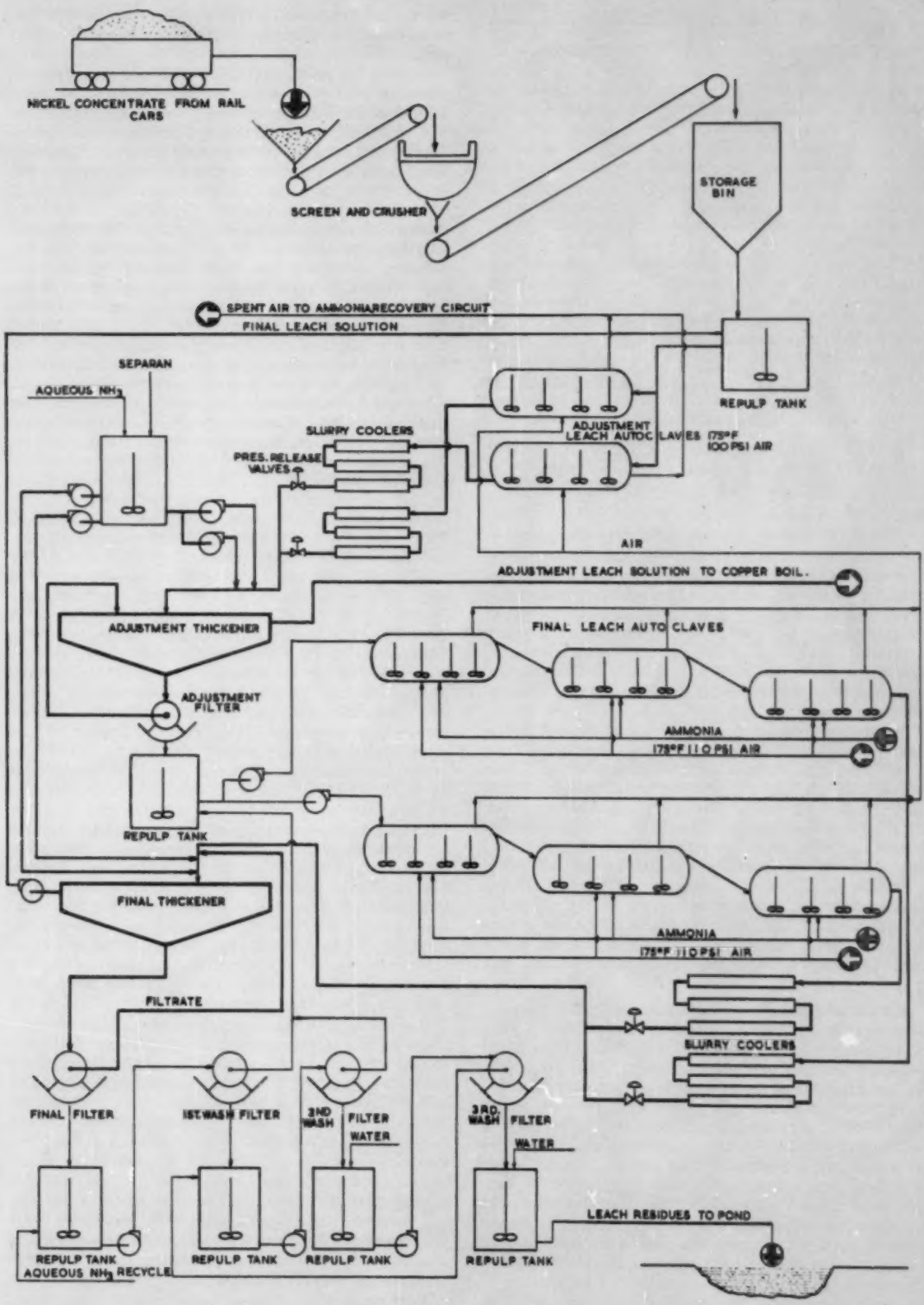

Fig. 1—Leach circuit with liquid-solids separation.

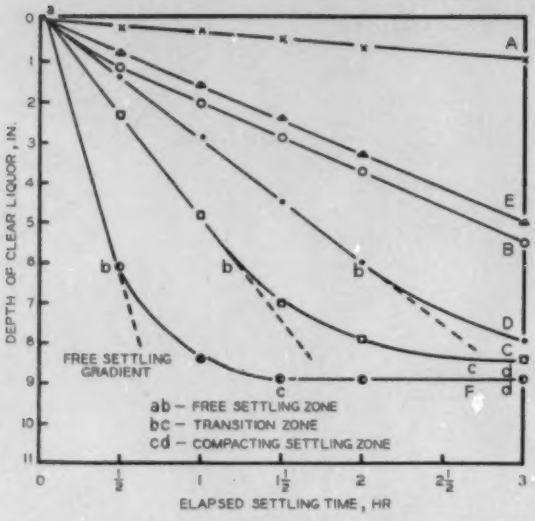

Fig. 2–The relationship between the depth of clear liquor and the elapsed settling time for samples of the final thickener feed treated with various flocculants.

eventually overflowed with the solution recycled to the adjustment leach circuit. Because of the recycled slimes, extremely slow-settling pulp was discharged to the adjustment thickener and the slimes level rose to overflowing. Subsequent process stages, unable to cope with large quantities of semicolloidal hydrated iron oxide, ceased to function satisfactorily and the concentrate feed rate to the autoclaves had to be cut to a minimum until conditions in the thickeners improved.

When the settling characteristics of the slurries in various parts of the circuit were correlated with plant operating variables and procedures, it was found that: 1) settling rates decreased progressively as the solids advanced through the leaching circuit, 2) slow settling was produced by operating at low feed rates, and 3) extremely slow settling resulted when feed to the autoclaves had to be shut off while agitation to prevent sanding up of the autoclaves was maintained without discharge of the solids. It was concluded that over-agitation during leaching was the main factor contributing to the excessive slimes burden on the liquid-solids separation circuits.

Effects of Operating Variables: With two parallel autoclave trains in both leaching circuits, it was possible to investigate the effect of agitation on a plant scale. When the original Struthers-Wells impellers in one adjustment leach autoclave were changed for swept-back turbine-type impellers, it was found that with equal slurry feed rates and power inputs to the two autoclaves, the thickening characteristics of the slurry discharged from the adjustment leach autoclave were noticeably improved, without any effect on the metallurgy. Further improvement was obtained by increasing the diameter of the turbine-type impellers while maintaining a constant power input. During these studies the settling rate of the slowest-settling particles, as indicated by the depth of clear liquor in a free-settling pulp, was used as the criterion of the probable behavior of the slurries during thickening. Table II shows the improved settling rate averaged over periods of one month by changing the impeller design. As a result of this study, the Struthers-Wells impellers in the leaching autoclaves were replaced by the modified turbine type.

During the plant study it was shown that the concentrate feed rate to the leaching autoclaves could be increased without lowering the metal extractions but with improved settling characteristics in the discharged pulps. The improved settling characteristics were anticipated because less work, in the form of attrition grinding by the agitators, would be done per unit weight of solids.

Simultaneously laboratory studies were carried out on possible causes of the slow-settling characteristics of the slurries. High leaching temperatures were shown to yield more stable dispersions of the hydrated iron oxides without improving extractions of the valuable metals. Since temperatures higher than the specified 175°F were being encountered in the final leach autoclaves during the start-up period, cooling coils were installed for better control.

The chief operational changes made to improve the liquid-solids separation were: 1) modified agitation and increased concentrate feed rate to decrease the attrition of solids and 2) improved control of leaching temperature. These changes were not enough to eliminate the sliming problem.

During the plant study, thickener area requirements were redetermined according to accepted procedures,[7,8] since design data had been obtained from the Ottawa pilot plant where there had been no difficulties in liquid-solids separation. It was found that under normal conditions and without allowing for a design safety factor, the final thickener, which handles the more difficult pulp, would have the capacity to handle the residues from leaching 200 tpd of concentrate. However, with slow-settling pulps, such as those discharged after a temporary shutdown for maintenance and those produced when slimes were recycled to the adjustment leach, throughput would be reduced so that less than 100 tpd of concentrate could be leached. The desired throughput at that time was 200 tpd. It was evident that the thickening characteristics of the leach slurries must be improved in order to avoid considerable expenditure on additional thickeners and filters. (Filtration characteristics were also poor.) A laboratory study was undertaken to find the most economic flocculant that would improve the thickening characteristics without affecting adversely the chemistry or operation of the remaining stages in the Sherritt Gordon process. Details of these investigations have been reported in an earlier paper.[9]

Flocculant Studies: In all the settling tests on plant slurries, the sands settled rapidly away from the slimes. This indicated that free settling conditions prevailed and that the slurries were well dispersed.

Earlier work, by other researchers, to improve the sedimentation of the red muds in the Bayer process, had shown that organic compounds such as flour and starch were the most useful for improving the separation of the colloidal iron oxide slimes from the caustic aluminate liquors.[10] In view of the similarity between the two slurries, laboratory studies were first concentrated on the available starches and starch products and were later expanded to cover commercial organic flocculants.

For initial evaluation of these materials, sedimentation tests were carried out in 1-liter glass graduate cylinders. Typical settling rate curves for the slowest-settling particles, obtained by plotting the depth of clear liquor against time, are shown in Fig. 2 for

final leach discharge slurries treated with various quantities of some of these flocculants.

Of necessity, the final leach discharge slurry samples for this work were taken over a period of weeks. Since the natural settling rates of these samples varied considerably, the settling rate ratios of the treated to the untreated slurries were taken as the criterion for comparing effectiveness of flocculants. The ratios were determined from the settling rates in the free-settling zones only (*ab* on the curves in Fig. 2).

Standard laboratory filtration tests were also carried out as part of the flocculant testing program. Here again the ratios of the filtration rates, determined on a dry solids basis, of the treated and untreated slurries were preferred for comparative purposes. With these ratios reproducible results were obtained consistently.

In the final evaluation, cost of the flocculants and cost of preparing them for use were related to their effectiveness in improving the settling and filtration rates. From this final evaluation, Dow Chemical Co. Separan 2610* was selected as being of most promise in overcoming the sliming problem.

* Now marketed as a purified product under the trade name Separan NP10.

Three months prior to this conclusion, the beneficial effect of American Cyanamid Aerofloc 552 had been demonstrated. Since this flocculant was readily available, it was added to both thickener feeds in quantities of 0.5 to 1.0 lb per ton of nickel concentrate. Although some improvement was obtained, sliming conditions still occurred periodically, and when Separan 2610 became available in commercial quantities a switch to this material was recommended. To summarize the advantages of Separan: 1) smaller quantities were required to produce the same improvement in settling rates, resulting in lower reagent costs, lower dilution of pregnant liquors, and greater flexibility in application, and 2) the incidence of compacting settling took place at a higher pulp density, which is desirable in a thickener employing a rake mechanism, and the compacting settling characteristics were improved.

Effect of Separan 2610: Before Separan 2610 could be recommended for plant use it was necessary to determine its effect on the other process stages. It was shown that large quantities added to a batch leaching charge in a laboratory autoclave did not affect the metals extractions or improve the settling rate of the slurry discharged. It was also shown, by a solution switching procedure, followed by repulping and redetermination of settling rates, that over 90 pct of the Separan 2610 added to the thickener feed would pass out of the circuit with the solids. It was further shown that if any Separan 2610 were carried over into the following process stages, then it, or at least its flocculating effect, would be destroyed in the high temperature stage (450°F, 700 psi) for the removal of undesirable sulfur compounds prior to hydrogen reduction. The fact that it would be destroyed in this stage was vitally important in clearing it for use in the refinery circuit, since its presence in the reduction autoclaves was shown to cause flocculation of the metallic nickel powder, resulting in poor operation in the batch reduction densification procedure employed.[10]

* Ed. Note: Adding Separan to the autoclave *feed* did not improve the settling characteristics of the autoclave *discharge*, i.e., Separan, or its effectiveness, was destroyed during leaching.

Flocculant stability tests indicated that the Separan 2610 should be added to the cooled autoclave discharge slurries at a point where the agitation was

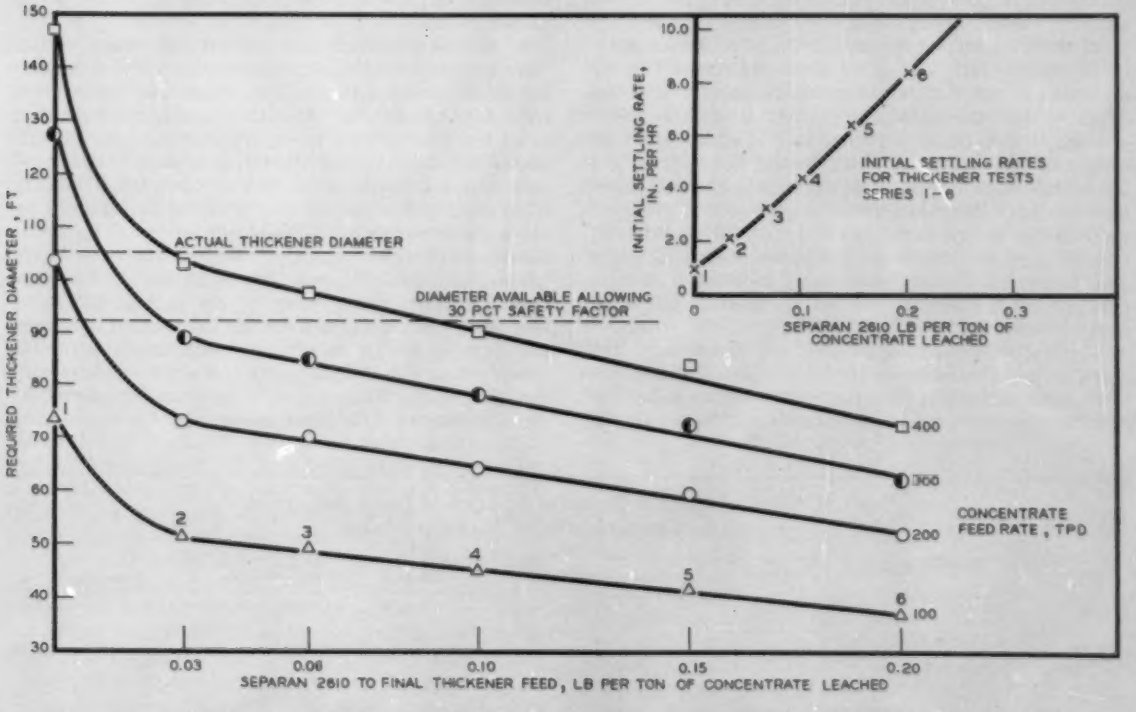
REQUIRED THICKENER DIAMETER, FT
ACTUAL THICKENER DIAMETER
DIAMETER AVAILABLE ALLOWING 30 PCT SAFETY FACTOR
CONCENTRATE FEED RATE, TPD
400
300
200
100
SEPARAN 2610 TO FINAL THICKENER FEED, LB PER TON OF CONCENTRATE LEACHED
INITIAL SETTLING RATE, IN. PER HR
INITIAL SETTLING RATES FOR THICKENER TESTS SERIES 1-6
SEPARAN 2610 LB PER TON OF CONCENTRATE LEACHED

Fig. 3—Relationship between the final thickener diameter requirements and the Separan 2610.

sufficient only for mixing prior to thickening. A two-point addition, as a 0.25 pct solution in cold water or, more recently, dilute aqueous ammonia, was adopted for each thickener feed.

To confirm that the faster initial settling rates would also mean improved thickening characteristics, thickener area requirements were determined[7,8] for slurries treated with various quantities of Separan 2610. In these tests, the thickened slurries were repulped to various dilutions and the settling rates at the various pulp densities were determined. It was then possible to determine the critical pulp density-settling velocity relationships and to calculate maximum area requirements. The thickener diameter requirements for various feed tonnages are plotted to a Separan 2610 addition abscissa in Fig. 3; the settling rate-flocculant addition relationship is shown in the inset. The curves show that after the first 0.03 lb of Separan 2610 per ton of concentrate fed to the circuit, there was an average reduction of 47 pct in thickener area requirements. Increasing the flocculant addition above 0.03 lb per ton progressively improves thickening characteristics but decreases the area requirements by only 25 to 30 pct (depending on the concentrate feed rate) for each additional 0.10 lb of Separan per ton of concentrate feed.

These curves indicate that the economic optimum addition, for a daily maximum feed rate of 300 tons of nickel concentrate, would lie between 0.03 and 0.06 lb per ton and that the inferences drawn from the settling rate data were completely justified.

During the start-up operations between May 1954 and January 1955, when design capacity of the refinery was attained, sliming conditions often occurred in the thickeners. Separan 2610 was received in commercial quantities on Jan. 19, 1955. At that time operation of the adjustment thickener was satisfactory with 30 to 40 in. of clear liquor, but overflow to the final thickener was turbid. It was recommended that 0.03 lb of Separan 2610 per ton of concentrate be added to the adjustment thickener feed and 0.06 lb per ton to the final thickener feed. By January 24th 70 in. of clear liquor was being maintained in the adjustment thickener and by January 28th the steady improvement in the depth of clear liquor (5 in. per day) had resulted in 45 in. of clear liquor in the final thickener. Except for two occasions when the rake mechanism was overloaded because the slimes load in the thickener was dropped too rapidly by an excessive Separan 2610 addition, operation of the thickeners has since been excellent and the residues from leaching up to 400 tpd of concentrate have been thickened without any recurrence of sliming.

Although Separan 2610 has given satisfactory results, new flocculants, as they become available, are evaluated following the procedures established in Sherritt Gordon's research laboratory. Aerofloc 550 (American Cyanamid), Polyox (Union Carbide) and Separan NP20 (Dow Chemical) have given promising results and are being further investigated to determine their effect on the remaining stages of the process.

Pumping: During the start-up period, pumping the thickener underflow presented a number of operating problems. The viscous, almost gelatinous underflow from the final thickener was particularly difficult, and there was hammering in the pumps and lines because of the high vapor pressure of the warm, highly ammoniacal slurries leading to vapor locks on the suction sides of the pumps.[5,9]

The original and present underflow pumping systems are compared in Fig. 4. The 3-in. pumps, of the enclosed VMA Dorrco diaphragm type, have an adjustable stroke and a rated capacity of 40 igpm. All wetted parts are of 304 stainless steel. At first these pumps were located at the top of the thickener straight-walls. After they were lowered 7½ ft and 3-in. underflow lines were substituted for the original 2-in. lines, the hammering ceased, and slurries of higher pulp density could be pumped from the thickeners. This proved advantageous in the subsequent filtration. As the Dorrco pumps are not designed to pump against more than a few inches of head, the transfer tanks also had to be lowered to the new location.

Initially 3-in. O.D.S. pumps were used for transferring the slurry, against the 27-ft head, up to the filters on the second floor of the leach plant. Considerable maintenance was necessary to keep the pumps, solenoids, and reducing valves in operation; on a number of occasions the tonnage had to be cut back. The 1½-in. Vacseal pumps now used on this service are required to pump against a 34-ft head. Wemco S.R.L. pumps have been used for this duty, but although the rubber in these pumps lasts longer than that in the Vacseal, they are used only on standby service because of dilution from the gland water.

It has been found that the rubber tears, rather than wears, from the impellers in the Vacseal pumps, probably because of surging when starved suction conditions exist. The Ni-hard impellers now being tried for this service have been satisfactory so far. Space limitations have restricted the size of the conical-bottom transfer tank to 3 ft diam by 3 ft high. Operation of the Dorrco and transfer pumps can be observed through a bull's-eye in the tank cover. A combination breather-overflow pipe extends from the top of the tank to a ditch on the main floor. This prevents spills from entering the pump room and thickener tunnel when the transfer pump fails. Since the start-up period this has not happened often, and when it has, the Dorrco pump has not been damaged because of the extra head. The transfer pumps on each thickener are inspected every three or four

Table II. Effect of Agitator Design in Adjustment Leach Autoclaves on Settling Characteristics of Discharged Pulps

Period	Autoclave	Type of Agitator	Average Settling Rate, In. Per Hr	Ratio — S.R. in A / S.R. in B	Pulp Density, Kg Per Liter	Extractions, Pct Ni	Extractions, Pct S
1	A	Struthers Wells	2.91	1.13	1.32	48	39
	B		2.57		1.33	49	37
2	A	Turbine; 30-in. diam	2.70	1.84	1.37	42	35
	B	Struthers Wells	1.47		1.37	44	38
3	A	Turbine; 30-in. diam	3.20	0.67	1.31	55	41
	B	Turbine; 36-in. diam	4.75		1.30	54	41

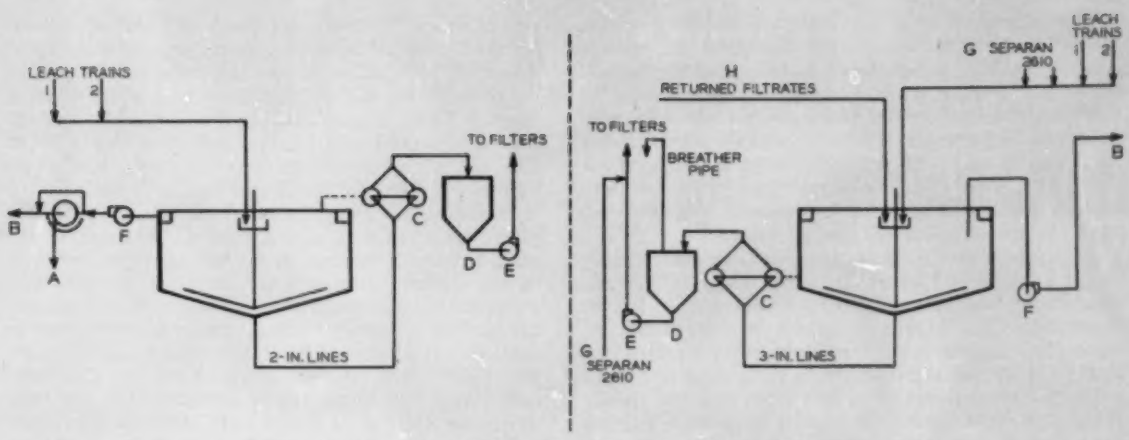

Fig. 4—Comparison of Original and Present Thickener Circuits.

Original Circuits

- A. *Drum clarifiers on adjustment thickener overflow only.*
- B. *Adjustment thickener overflow to copper boil stage. Final thickener overflow to adjustment leach.*
- C. *40-I.G.P.M. Dorrco underflow pumps at top of straight walls.*
- D. *Transfer tanks (conical bottom, stainless steel.)*
- E. *3-in. O.D.S. pumps.*
- F. *100-I.G.P.M. Worthington 2-C.G.I. pumps.*

Present Circuits

- A. *Drum clarifiers eliminated.*
- B. *Adjustment thickener solution siphoned out to copper boil stage.*
- C. *40-I.G.P.M. Dorrco underflow pumps 7½ ft below top of straight walls.*
- D. *Transfer tanks lowered 7½ ft.*
- E. *Vacseal rubber-lined centrifugal pumps.*
- F. *150-I.G.P.M. Canada pumps.*
- G. *Separan 2610 addition points.*
- H. *Filtrates returned to thickeners.*

weeks. Although centrifugal pumps are used, the filtration characteristics of the slurries are only slightly worsened by attrition of the floccules.

Emptying the Thickeners: On three occasions it was necessary to empty one of the thickeners for maintenance purposes. Each thickener has a capacity of 540,000 Imperial gallons of pregnant liquor. During the emptying procedure, it is essential to recover this solution in a form suitable for further processing. A heavy dose of Separan 2610 is added to increase the depth of clear liquor to a maximum. The overflow pump suction pipe is then lowered and all the clear liquor is pumped either into the 540,000-gal storage tank normally used for overflow liquor from the adjustment thickener or into the three 100,000-gal storage tanks normally used for copper-free liquor. Thus little time is lost when the thickeners are emptied, provided the storage tanks themselves are sufficiently empty. When the adjustment thickener is emptied, the Dorrco underflow pump is replaced by a centrifugal pump of higher capacity to speed the solids through the circuit. When the final thickener is emptied, efficiency of the filters drops as density of the underflow falls. A switch to two parallel trains of two filters is adopted, but with further lowering of the underflow density, filtration is discontinued and the underflow is pumped into the adjustment thickener at the expense of some dilution of the adjustment leach solution.

After the slurry is pumped out, the remaining solids are hosed out and the ammonia fumes are blown out before the maintenance crews are permitted to enter. The 30 x 30-in. opening, normally fitted with a relief valve, and the manhole in the dome are used for blowing in air and venting the ammonia fumes. Gas tests are made after all lines have been blanked off and all switches locked. No cutting or welding is permitted until these precautions have been carried out.

Other Problems: Torque overloading of the rake mechanisms often occurred during start-up when there were pumping difficulties and slow filtration of the excessively slimy pulps. Overloading, indicated by high readings on the ammeters, was accompanied by an automatic rise of the rakes. When overloading was extreme, the rakes were raised by a hydraulic jack located on the lift beam above the drive. As the load lightened they were gradually lowered to their normal position. The ammeters on the power supply for the rakes are conveniently located on the operating floor and are duplicated in the leach plant control room. Since the start-up period, overloading has occurred only when an excessive flocculant addition has caused a sudden drop of a heavy load of slimes.

There has been little trouble with island formation in the thickeners. On the two occasions when islands did form, they were attributed to a localized effect, on part of the slimes load, from an excessive addition of flocculant. Islands were indicated when the rakes rode high and nothing but solution was siphoned out through the underflow pump. To correct this condition, the valve on the underflow line was closed and the compressed air was turned on for a time. The underflow thickened rapidly and the rakes returned to normal as the heavy load of accumulated solids was pumped from the thickener.

PRESENT OPERATION

The slurry is discharged from the autoclaves by pressure and is cooled prior to thickening. Level controls in the autoclaves prevent the gases from being blown out with the slurry, and the temperature of the thickener feed is closely controlled at 90°F. These precautions minimize disturbance of the settling solids either by gas release or flashing.

The slurry lines from the two leaching trains merge a short distance after the pressure release valves. At this point there is considerable turbulence in the pipe. This has proved a good place to add the flocculant, since thorough mixing is rapidly achieved. Separan 2610 is fed in at two points, about 1 yd apart, as a 0.25 pct solution in dilute aqueous ammonia. Two Orchem adjustable-stroke proportioning pumps of 0 to 15-gal per hr capacity are used to control the flocculant addition.

Flocculant addition is governed by the slurry settling rates both before and after Separan 2610 has been added and by the height of the slimes in the thickeners. The height of slimes is determined by lowering a pipe into the thickener, drawing up solution by a vacuum through a flexible pipe into a 12 x 12-in. cone-bottom tank, and observing the clarity through a sight glass. The pipe is hung by a T-hook over pins on a scale graduated in inches. The solution is drained back into the thickener and the operation is repeated after each adjustment of the tell-tale pipe until a change from clear to cloudy is noted.

The thickeners are presently being used for solution storage as well as for thickening.[5,8] This is accomplished by keeping the slimes level 40 to 70 in. below the overflow launder and by pumping out the solution through a siphon pipe instead of allowing it to overflow. The 100-igpm Worthington 2CG1 pumps originally installed for the overflow solution have been replaced by 150-igpm Canada pumps to handle the increased plant throughput.

Solution level indicators of the bubbler type are used in the thickeners. Final thickener level is kept 15 to 20 in below the overflow launder. This provides surge space and enables partially treated concentrate to be handled in the final leach circuit during an adjustment leach shutdown. It also provides space for the contents when a 17,000-gal autoclave is emptied for inspection or maintenance. This procedure has avoided the cost of new stainless steel storage tanks, conserved floor space, and facilitated the slurry handling problem.

Pulp density of the adjustment thickener underflow is controlled to about 2.000 sp gr (50 pct solids by weight) by adjusting the stroke on the Dorrco underflow pump. Pulp specific gravities as high as 2.100 or 2.200 can be handled satisfactorily, but above this a continuous stream of water must be fed into the thickener cone.

The final thickener underflow is considerably more viscous; consequently a lower specific gravity of about 1.800 (57 pct solids by weight) is necessary to obtain satisfactory pumping. Here again, dilution water to the thickener cone is used to lower the density. The final thickener underflow is recirculated only when it is necessary to raise the underflow pulp densities to these optimum values.

COUNTERCURRENT DECANTATION VS THICKENING AND FILTRATION

Capital cost estimates prepared from pilot plant data showed that in 1953 a CCD circuit for separating and washing the final leach residues would cost about $700,000 more than the thickener-filters circuit. The comparison was based on the assumption that the two circuits would have the same washing efficiency and that the same overall water balance would have to be maintained. At that time, and without the use of flocculants, it was estimated that six 108-ft diam thickeners in CCD would be required to equal the performance of the filter wash circuit, operating on the residues from 200 tpd of concentrate. Estimated operating costs were shown to be lower for CCD than for the thickener-filters circuit, but it was also shown that the plant would have to operate 10 to 12 years before the savings in operating costs would pay off the increased capital cost. The lower capital outlay was obviously preferable and the thickener-filter circuit was installed.

Modifications and improvements to the thickener-filters circuit have made it possible to separate and wash the leach residues from 400 tpd of concentrate in the equipment originally installed. Despite this considerable achievement the availability of powerful synthetic flocculants has changed the picture to such an extent that if the choice had to be made today (1958), the economics would favor a CCD circuit. Using 0.22 lb per ton of Separan 2610, the residue from 400 tpd of concentrate could be washed in a CCD circuit of six 84-ft diam thickeners. Such a circuit would require a capital outlay of $280,000 more than the corresponding thickener-filters circuit, but the savings effected in operating costs would pay off the increased capital cost in about two years.

It should be emphasized that this comparison is only applicable in the design of a new plant. There is no justification for replacing existing equipment with a CCD circuit, because the $1.5 million capital investment required could not be paid off by the estimated savings in operating costs in less than ten years.

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CHARACTERISTICS OF COAL PREPARATION PLANT SLURRIES

by H. B. CHARMBURY and D. R. MITCHELL

Everyone in the coal industry from top management to the preparation engineer is vitally interterested in recovering as much salable coal as possible from the run-of-mine product. Coal losses from a preparation plant occur in the solid refuse material being discharged from the plant and in the bleed-off slurry from the water circuit. The refuse is generally hauled from the plant in solid form by trucks, conveyors, or aerial trams to the refuse or culm banks or it may be crushed and transported by hydraulic methods to refuse ponds or dams. The loss of coal in refuse material and the extent of this problem has been covered in another paper.[1] The loss of salable coal in the plant bleed-off slurry is one of the water circuit problems in coal preparation plants. Slurries originate at various places in the processing circuits and are usually disposed of by transportation to waste ponds known as slurry ponds.

Even though the combustible material discharged as slurry and refuse from the plant is labeled a loss, the loss must only be considered temporary. There is a tendency at the present time to examine refuse and slurry losses and to reprocess these materials to recover valuable coal.

Slurries from eight bituminous coal preparation plants in central and western Pennsylvania have been sampled and examined to determine the amount of recoverable coal in each. Examinations of the samples were made to determine the tons per hour of solids and the gallons per minute of water in the slurry; the size, ash, and sulfur analyses of the solids; and the sink-float characteristics of the larger solids. The extreme fines (−325 mesh material) from one of the samples has been examined further to determine the micron size fractions as well as the ash and sulfur content of the micron sizes.

Collection of the Samples: Field trips were made to each of the plants where samples were obtained and discussions held with the preparation engineer prior to sampling. The flowsheet of the plant operation was studied and a time-period selected to obtain a representative sample. At least 20 1-gal samples of total plant bleed-off suspensions were collected at each plant in increments over designated periods belived to be typical of the plant flow.

Three of the samples were obtained from plants in the Pittsburgh area. Each plant supplied information on the capacity, operating time, type of cleaning equipment used, water and material balances, and auxiliary equipment. From the time required to collect given amounts of slurry and from the amount of solids in the slurry, total solids discharges from the plant were calculated and compared with the plant flow. Ash and sulfur analyses of the total solids were also checked, at some plants, with company figures. In all cases where checks could be made there was reasonable agreement between company figures and those reported here.

Analysis of the Slurries: Representative fractions of properly agitated samples were examined in the laboratory to determine the specific gravities of the slurries. The solids and water were separated by filtration to check the weight of each so that the percent of solids in the pulp could be determined. From the resulting data, presented in Table I, it may be seen that the percent solids in the slurries ranges from 2.8 to 39.0 and the amount of solids from 2.61 to 45.61 tph.

Table I. Slurry Flow Data

Plant	Slurry, Gpm	Slurry, Sp Gr	Solids, Pct	Solids, Tph
A	400	1.173	39.0	45.61
B	400	1.098	21.1	23.21
C	400	1.034	7.8	8.04
D	300	1.023	7.6	5.82
E	340	1.092	32.7	30.28
F	200	1.022	7.6	3.87
G	360	1.010	2.8	2.61
H	90	1.087	27.6	6.76

Size Analysis of Solids: Representative fractions of the slurries were permitted to settle and the clear water was removed by siphoning. The solids were then wet-screened at 28, 35, 48, 65, 100, 150, 200 and 325 mesh. Results of the size analyses are presented in Table II. These results indicate the extreme variation of sizes and in most cases the degree of fineness of the solids. The amount of −325 mesh ranges from 22.5 to 84.5 pct and the amount of +200 mesh from 8.3 to 69.1 pct.

H. B. CHARMBURY, Member AIME, is Head, Department of Mineral Preparation, and D. R. MITCHELL, Member AIME, is Acting Dean, College of Mineral Industries, The Pennsylvania State University, University Park, Pa. TP 59886. Manuscript, March 20, 1959. San Francisco Meeting, February 1959. AIME Trans., Vol. 217, 1960.

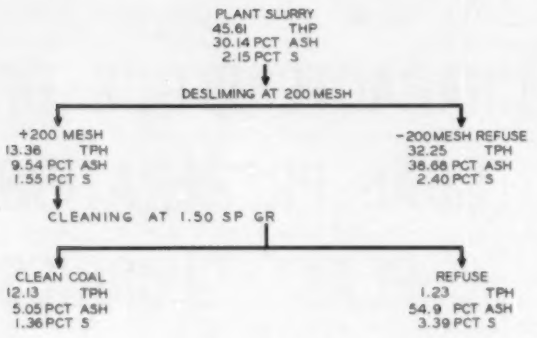

Fig. 1. Plant A

Chemical Analysis of the Solids: Owing to the relatively small amount of material in some of the size fractions it was impossible to obtain a chemical analysis of each size. Thus several size fractions from the various samples were combined and analysed for ash and sulfur. These results, given in Table III, are on a dry basis. From these data it may be seen that the dry ash in the slurry solids ranges from 10.08 to 38.74 pct and the dry sulfur from 0.99 to 2.88 pct. In five of the eight plants the percentage of both ash and sulfur are low enough for the solids to represent a marketable product, provided they could be recovered and blended with other clean coal from the plant. The dry ash and sulfur values of these five samples are all in the range of 10.08 to 13.64 pct and 0.99 to 2.88 pct, respectively.

Washability Analysis of +200 Mesh Solids: Washability or sink-float data at 1.50 sp gr were obtained on all combined size fractions above 200 mesh. These analyses were made to determine possible grades and recoveries when the +200 mesh portion of the slurries were cleaned. The results, listed in Table IV, indicate high grades and high recoveries in all cases. Recoveries run from 75.2 to 98.8 pct, and the ash and sulfur contents of the clean coal or float fractions are all in the marketable range. The percent ash in the float products ranges from 2.76 to 5.12 and the percent sulfur from 0.50 to 1.56.

Examination of −325 Mesh Solids: It was pointed out previously that 22.5 to 84.5 pct of the solids in the various slurries were −325 mesh, air-dry basis. One of these samples from the western Pennsylvania area was examined to determine the size consist and chemical analysis of the —325 mesh portion of the slurry.

A size analysis was attempted by a sedimentation process but results were not satisfactory. It was believed that the inconsistent values obtained were due to traces of oil on the solids hindering natural settling. Centrifuging the samples at 2500 rpm was found to produce distinct layers of solids ranging in color from a light yellow to green to brown to dull and light gray from bottom to top. When the centrifuge was manipulated at different speeds, ranging from 250 to 2000 rpm, for different lengths of time the various color fractions could be separated and removed one at a time.

After the individual fractions were obtained they were dried and weighed to determine the weight percent, and then ash and sulfur analyses were made of each fraction. Finally, individual particles were examined microsopically to obtain some indication of the exact size range. The results are presented in Table V.

The first fraction to be removed contained relatively large pyrite particles. The size range was 15 to 75μ, the ash content 45.8 pct, and the sulfur 4.96 pct. The second fraction contained primarily large coal particles from 5 to 45μ in size. Ash content was 35.0 pct and the sulfur 1.85 pct. Fractions 3, 4, and 5 were progressively smaller and smaller particles, showing an increase in ash content and a decrease in sulfur content with decrease in size. Positive identification of the particles became more difficult as the size decreased.

EVALUATION OF RESULTS

Examination of all the data revealed that each plant must be considered as an individual case. At some plants recovery of the solids as they exist would produce a low-grade marketable product, at some plants a desliming operation at 200 mesh followed by recovery of the coarse fraction would be necessary, and at others desliming followed by cleaning of the coarse fraction would be required to obtain a high-grade product. An evaluation of each plant is presented below.

Plant A: This plant has a capacity of 1200 tph run-of-mine coal. The data in Table I indicate that 45.61 tph of dry solids or about 3.8 pct of the solid input to the plant is being discharged to the slime pond. At the time of sampling, the plant was operating 14½ hr per day 4½ days per week. The solids being discharged were coming from a Dorr thickener underflow and the feed to the thickener was composed of approximately 50 pct floation tailings and 50 pct overflow from a free-discharge Rheo refuse tank. The solids contained 30.14 pct ash and 2.15 pct S, dry basis.

Fig. 1 shows that it is theoretically possible to recover 13.36 tph by desliming at 200 mesh. Removal of the —200 mesh fraction would result in a product with 9.54 pct ash and 1.55 pct S. Under certain conditions this could be mixed with other products of the plant and marketed. This recovery would be equivalent to 193.72 tpd. By cleaning the deslimed product at 1.50 sp gr it was shown that the coal may be upgraded to 5.05 pct ash and 1.36 pct S. Under these conditions the recovery would drop to 12.13 tph, or 175.88 tpd. Progress is now being made at this plant to recover the deslimed material.

Plant B: At the time of sampling this plant was operating 14½ hr per day, 5 days a week. It was processing 17,500 tons of ROM coal per day and recovering 13,000 tpd of clean coal. Data in Table I indicate that dry solids in the plant's slurry discharge amounted to 23.21 tph, or 336.55 tpd, equivalent to 1.94 pct of the total product being processed. The solids in the slurry contained 38.74 pct ash and 1.81 pct S. The slurry originated as the underflow from a thickener handling wash water from concentrating table refuse.

The data in Tables II, III and IV show that it is theoretically possible to recover 2.65 tph or 38.42 tpd of coal by desliming at 200 mesh and that the recovered coal could have 11.13 pct ash and 1.74 pct S. Furthermore, cleaning the deslimed product at 1.50 sp gr would produce a clean coal with only 4.98 pct ash and 1.34 pct S. In this case recovery of clean coal would be reduced to 2.32 tph or 33.64 tpd.

Plant C: Operating 14½ hr per day, for a 5-day week, this plant was processing 9000 tpd of ROM coal. The slurry contained 8.04 tph of solids, or approximately 1.3 pct of the total feed solids. The

Table II. Size Analyses of the Solids

Mesh Size	Plant A Wt, Pct	Plant A Cum Wt, Pct	Plant B Wt, Pct	Plant B Cum Wt, Pct	Plant C Wt, Pct	Plant C Cum Wt, Pct	Plant D Wt, Pct	Plant D Cum Wt, Pct	Plant E Wt, Pct	Plant E Cum Wt, Pct	Plant F Wt, Pct	Plant F Cum Wt, Pct	Plant G Wt, Pct	Plant G Cum Wt, Pct	Plant H Wt, Pct	Plant H Cum Wt, Pct
+28	1.1	1.1	0.0	0.0	0.0	0.0	0.7	0.7	0.2	0.2	29.8	29.8	0.1	0.1	0.0	0.0
28x35	1.9	3.0	0.0	0.0	0.0	0.0	1.3	2.0	0.1	0.3	7.4	37.2	0.1	0.2	0.2	0.2
35x48	2.9	5.9	0.0	0.0	0.2	0.2	1.3	3.3	0.1	0.4	7.6	44.8	0.3	0.5	1.8	2.0
48x65	4.8	10.7	0.8	0.8	0.4	0.6	2.2	5.5	0.7	1.1	7.4	52.2	0.9	1.4	4.2	6.2
65x100	6.3	17.0	3.2	4.0	1.5	2.1	3.8	9.3	4.8	5.9	6.8	59.0	2.3	3.7	7.2	13.4
100x150	7.0	24.0	4.3	8.3	3.4	5.5	5.4	14.7	12.6	18.5	6.1	65.1	3.7	7.4	9.1	22.5
150x200	5.3	29.3	3.1	11.4	2.8	8.3	6.4	21.1	11.7	30.2	4.0	69.1	2.9	10.3	7.2	29.7
200x325	14.2	43.5	9.0	20.4	7.2	15.5	14.2	35.3	22.4	52.6	8.4	77.5	20.5	30.8	16.6	46.3
−325	56.5	100.0	79.6	100.0	84.5	100.0	64.7	100.0	47.4	100.0	22.5	100.0	69.2	100.0	53.7	100.0

Table III. Chemical Analyses of the Solids

Plant A

Mesh Size	Wt, Pct	Ash, Pct	S, Pct
+65	10.7	7.24	1.49
65 x 200	18.6	10.87	1.58
−200	70.7	38.68	2.40
Head	100.0	30.14	2.15

Plant B

Mesh Size	Wt, Pct	Ash, Pct	S, Pct
+100	4.0	7.85	1.63
100 x 200	7.4	12.90	1.80
−200	88.6	42.29	1.61
Head	100.0	38.74	1.62

Plant C

Mesh Size	Wt, Pct	Ash, Pct	S, Pct
+150	5.5	4.74	0.68
150 x 200	2.8	6.05	0.76
−200	91.7	39.43	1.93
Head	100.0	36.59	1.85

Plant D

Mesh Size	Wt, Pct	Ash, Pct	S, Pct
+100	9.3	10.19	1.65
100 x 200	11.8	5.79	1.35
−200	78.9	13.09	1.12
Head	100.0	11.17	1.20

Plant E

Mesh Size	Wt, Pct	Ash, Pct	S, Pct
+100	5.9	3.74	0.90
100 x 200	24.3	4.37	0.84
−200	69.8	12.60	1.66
Head	100.0	10.08	1.42

Plant F

Mesh Size	Wt, Pct	Ash, Pct	S, Pct
+65	52.2	8.90	1.92
65 x 200	16.9	17.34	3.05
−200	30.9	19.48	4.40
Head	100.0	13.64	2.88

Plant G

Mesh Size	Wt, Pct	Ash, Pct	S, Pct
+100	3.7	8.72	1.21
100 x 200	6.6	8.17	1.00
−200	89.7	11.46	1.25
Head	100.0	10.94	1.23

Plant H

Mesh Size	Wt, Pct	Ash, Pct	S, Pct
+100	13.4	3.90	0.83
100 x 200	16.3	4.50	0.77
−200	70.3	15.90	1.07
Head	100.0	12.45	0.99

Table IV. Washability Data on +200 Mesh Sizes at 1.50 Sp Gr

Mesh size	Plant A +65 Wt, Pct	Plant A +65 Ash, Pct	Plant A +65 S, Pct	Plant B +100 Wt, Pct	Plant B +100 Ash, Pct	Plant B +100 S, Pct	Plant C +150 Wt, Pct	Plant C +150 Ash, Pct	Plant C +150 S, Pct	Plant D +100 Wt, Pct	Plant D +100 Ash, Pct	Plant D +100 S, Pct
Float	93.7	5.10	1.36	93.0	4.78	1.30	92.8	2.83	0.80	89.9	4.49	0.95
Sink	6.3	39.20	3.34	7.0	48.55	5.09	7.2	29.46	3.13	10.1	60.77	7.25
Head	100.0	7.24	1.49	100.0	7.85	1.63	100.0	4.74	0.68	100.0	10.18	1.65
Mesh size	65 x 200			100 x 200			150 x 200			100 x 200		
Float	89.4	5.01	1.36	85.7	5.10	1.36	87.1	3.06	0.52	93.9	3.04	0.83
Sink	10.6	60.15	3.41	14.3	59.59	4.23	12.9	26.29	2.36	6.1	48.50	9.80
Head	100.0	10.87	1.58	100.0	12.90	1.80	100.0	6.05	0.76	100.0	5.79	1.35

Mesh size	Plant E +100 Wt, Pct	Plant E +100 Ash, Pct	Plant E +100 S, Pct	Plant F +65 Wt, Pct	Plant F +65 Ash, Pct	Plant F +65 S, Pct	Plant G +100 Wt, Pct	Plant G +100 Ash, Pct	Plant G +100 S, Pct	Plant H +100 Wt, Pct	Plant H +100 Ash, Pct	Plant H +100 S, Pct
Float	98.4	2.76	0.73	90.5	5.12	1.53	91.6	3.38	0.84	98.8	3.44	0.68
Sink	1.6	63.40	10.87	9.5	45.91	5.68	8.4	66.67	5.29	1.2	42.49	14.30
Head	100.0	3.74	0.90	100.0	8.99	1.92	100.0	8.72	1.21	100.0	3.90	0.83
Mesh size	100 x 200			65 x 200			100 x 200			100 x 200		
Float	98.3	3.88	0.84	75.2	4.59	1.56	95.1	3.44	0.82	97.9	4.09	0.72
Sink	1.7	32.72	0.84	24.8	54.86	7.62	4.9	38.43	4.63	2.1	27.65	3.45
Head	100.0	4.37	0.84	100.0	17.34	3.05	100.0	5.17	1.00	100.0	4.59	0.77

Table V. Size and Chemical Analyses of Centrifuge Products from the +325 Mesh Solids, Plant A*

	−325 Mesh, Wt, Pct	Total Solids, Wt, Pct	Approximate Size, Microns			Ash, Pct	S, Pct	Cumulative	
			Min	Avg	Max			Ash, Pct	S, Pct
Fraction No. 1	31.2	17.6	15	45	75	45.8	4.96	45.8	4.96
Fraction No. 2	22.5	12.7	5	29	45	35.0	1.85	41.3	3.66
Fraction No. 3	32.6	18.4	3	12	30	46.9	1.14	43.4	2.71
Fraction No. 4	12.1	6.9	—	4	13	67.3	0.78	46.3	2.47
Fraction No. 5	1.6	0.9	—	1	5	87.8	0.93	47.0	2.45
	100.0	56.5							

* 56.5 pct of the solids −325 mesh.

solids, containing 36.59 pct ash and 1.85 pct S, originated as overflow materials from concentrating table settling tanks. They were extremely fine in size, 91.7 pct −200 mesh. However, removal of the −200 mesh slimes produced a relatively clean coal with 5.19 pct ash and 0.71 pct S. The amount of clean coal produced by desliming at 200 mesh would be 0.67 tph or 9.72 tpd. Cleaning the deslimed product at 1.50 sp gr would yield 0.61 tph or 8.84 tpd of clean coal with 2.92 pct ash and 0.51 pct S.

Plant D: Operating 24 hr a day, 5 days a week, this plant was processing 6000 tpd of ROM coal and producing 4600 tpd of clean coal. The discharge slurry originated from several sources—overflow from a concentrating table settling tank, overflow from a chance cone system, and scrubbings from cleaning the gases of two flash driers. The slurry was being pumped to a deep mine. Solids amounted to 5.82 tph, or 139.68 tpd, equivalent to about 2.3 pct of the feed coal to the plant. The solids contained only 11.17 pct ash and 1.20 pct S. The slurry contained only 7.6 pct solids, but thickening and filtering alone would recover a salable product that could be blended in with the other clean coal from the plant.

Plant E: This plant was also operating 24 hr per day, 5 days per week, and producing 4800 tpd of clean coal. Slurry from the plant was a thickener underflow containing 32.7 pct solids. The solids only contained 10.08 pct ash and 1.42 pct S. Recovery of this material and blending with other plant products would increase plant production by 726.72 tpd, or approximately 15 pct. Steps are being taken to recover this material.

Plant F: At 14½ hr per day, 5 days a week, capacity of plant *F* was 200 tph of ROM material. Total slurry amounted to about 1.4 pct of the plant input, or 3.87 tph of dry solids. The slurry originated as fine coal overflow from a Chance cone system and as a spray water suspension from scrubbing gases from a thermal dryer. Solids in the slurry contained 13.64 pct ash and 2.88 pct S. Thickening and filtering this slurry, which contained only 7.6 pct solids by weight, would result in marketable product that could be blended with other plant products. The data in Tables II, III, and IV show that desliming and cleaning at 1.50 sp gr will result in 2.32 tph, or 33 tpd of clean coal containing 5.08 pct ash and 1.54 pct S.

Plant G: This plant was producing 25,000 tons of clean coal per week by operating 24 hr per day 5 days a week. The slurry from the plant contained 2.8 pct solids by weight and the solids amounted to 2.61 tph. On a dry basis the solids contained 10.94 pct ash and 1.23 pct S. The solids in the slurry originated as overflow material from a Chance process and overflow from a settling tank recovering fine coal from a tabling operation.

Thickening and filtering these solids would result in increasing the recovery about 1 pct, or roughly 62.64 tpd. By desliming at 200 mesh and cleaning the deslimed product at 1.50 sp gr the clean coal product could be upgraded to 3.42 pct ash and 0.83 pct S. However, in this case the recovery would drop to 0.25 tph or 6.00 tpd.

Plant H: Operating 14½ hr per day for a 5-day week, plant *H* was processing 156 tph of ROM material and producing 135 tph of clean coal. The slurry contained 6.76 tph of solids on a dry basis, equivalent to about 4.3 pct of the plant feed. The slurry originated as underflow material from cyclones and contained about 15 pct solids.

Recovery of the solids which contain 12.45 pct ash and 0.99 pct S would increase production 5.0 pct and result in an additional 98.02 tpd of cleaning coal. Desliming at 200 mesh and cleaning the +200 mesh at 1.50 sp gr would lower recovery to 1.98 tph, or 28.71 tpd, but the clean coal would be upgraded to 3.79 pct ash and 0.70 pct S. By desliming at 200 mesh and recovering the +200 mesh fraction it would be possible to recover 2.01 tph or 29.14 tpd of clean coal with 4.28 pct ash and 0.80 pct S. This would result in an increase in production of 3.1 pct.

SUMMARY

Waste solids in the slurries from eight preparation plants in Pennsylvania ranged from 56 to 725 tpd and averaged 230 tpd. In some surries all the solids were low enough in ash and sulfur to represent salable coal. In other slurries the solids would have to be processed to be marketable, and in these cases recoveries may be as low as 10 pct. But if the average figure of 230 tpd is applied to the 96 coal preparation plants in Pennsylvania alone, more than 4 million tons of recoverable coal are being discharged from these plants. Assuming an average value of $3.00 per ton, this is equivalent to a $12 million loss per year.

It is recognized that recovery of solids from slurry material is a matter of economics and that in some cases known methods of coal-water separations would not be satisfactory to recover this material. However, it is recommended that consideration be given to the problem and that research be conducted on new, more efficient, and more economical methods of recovering coal from preparation plant slurries.

REFERENCE

[1] H. B. Charmbury: Phantom Product—Mine Refuse. *Mechanization*, May 1958, vol. 22, pp. 46-52.

Discussion of this article sent (2 copies) to AIME before Feb. 29, 1960, will be published in MINING ENGINEERING.

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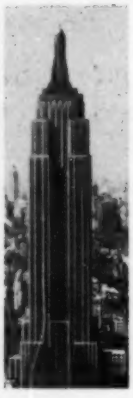

ANNUAL MEETING—1960

This January issue is filled with last-minute Annual Meeting information. Those SME abstracts received too late for the December issue are printed on pages 22 and 23. Details of the SME program (up-to-date to issue deadline) begin on page 23. A list of awards and honors to be presented at the meeting are given on page 27. A calendar of events on page 28 is your guide to breakfasts, luncheons, dinners, and committee meetings. Times and places of technical events have been omitted, since these are subject to last minute changes. Please consult the official AIME program, to be distributed at the meeting, for accurate time and place information for ALL events you plan to attend. More complete data on award winners is given in stories on: MIE Award, page 54; Erskine Ramsay Gold Medal, Coal News; and Hal Hardinge Award, IndMD Newsletter. Information on a luncheon speaker is given on page 59 and page 54 carries a report on SME Education session plans. SME Headquarters: Statler-Hilton Hotel.

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NEWSLETTERS . . .
- Coal page 56
- IndMD page 57
- MBD'ers Digest page 58

Mineral Information Section Begins on Page 4

"Old" and "New"
SME BOARD OF DIRECTORS
Monday, February 15
9:30 am — Hartford Room
—all day — Statler-Hilton

MBD Session

Plans for one of the eight MBD Annual Meeting sessions is the subject of this month's MBD'ers Digest. Magnetizing roasting of iron ore is the theme—Page 58.

SME NOMINATING COMMITTEE
Tuesday, February 16
9:30 am — Buffalo Room
Statler-Hilton

AIME 1960 PACIFIC NORTHWEST REGIONAL CONFERENCE, PORTLAND

Further details of plans for this annual AIME regional meeting are given on page 55. Map stars indicate places at which the conference is held in rotating years: Portland, Seattle, Spokane.

AIME PACIFIC SOUTHWEST REGIONAL METALS & MINING CONFERENCE—PAGE 55

MINNESOTA

AIME Minnesota Section Annual Meeting and the annual Mining Symposium of the University of Minnesota (see page 59) will be held in Duluth, January 11 to 13.

Proposals for Membership
Change of Address
Personals Data
Boxes
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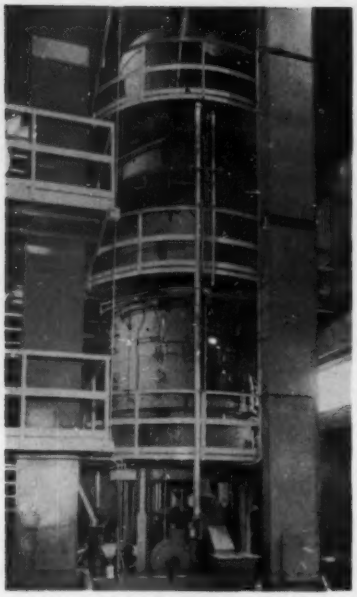

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L. C. Uren To Be Given AIME Education Award

The AIME Mineral Industry Education Award will be presented at the Annual Meeting in February to Lester Charles Uren, professor emeritus of petroleum engineering at the University of California.

Mr. Uren is hailed in the citation for his pioneering work that "outlined and delineated in detail the present and future areas of petroleum production, engineering and research, particularly through his

LESTER CHARLES UREN, 1960 MIE AWARD

decimal classification system for the filing of data pertaining to the petroleum and related industries, and the numerous editions of his textbooks on petroleum, exploration, development, exploitation engineering and petroleum economics."

Professor Uren attended the California School of Mechanical Arts in San Francisco. He graduated from the University of California in 1911 and was acting dean of the College of Mining and chairman of the Dept. of Mining and Metallurgy. He has served on numerous committees to further petroleum engineering education and has published over 170 articles that have contributed to the field.

SME Educators Prepare Annual Meeting Session

On Sunday afternoon, February 14, the SME Education Committee plans a session at the Statler Hilton Hotel. It is scheduled to start at 2 pm. The meat of the session will be a candid appraisal of Mineral Industry Education in the U. S. and Canada. Those who will formally discuss the subject "Mining Education—Pheonix or Dodo" are: H. R. Rice, head of the mining department, University of Toronto, Toronto, Canada. J. D. Reilly, vice president, operations, The Hanna Coal Co., Cadiz, Ohio. A. W. Knoerr, editor, *Engineering & Mining Journal*, New York. Stanley D. Michaelson, chief engineer, Western Mining Div., Kennecott Copper Corp., Salt Lake City.

Following the last speaker, the meeting will be thrown open to discussion of the subject, *with no holds barred.*

This session alone should make early arrival at the convention well worth while. However, there will

be a buffet supper preceded by a convivial get together. At these the miners will be joined by those who have attended the afternoon programs of The Metallurgical Society and Society of Petroleum Engineers Education Committees.

After dinner all three societies will join for the presentation of the MIED award to L. Charles Uren and to hear Elmer W. Pehrson, head of the Foreign Region of the U. S. Bureau of Mines. In his talk he will touch on mining education behind the iron curtain.

Chairmen are Planning Northwest Conference

More than 500 delegates and wives are expected to attend the 13th annual Pacific Northwest Metals and Minerals Conference to be held in Portland April 28 to 30. There will also be sessions with American Society of Metals.

Conference site will be Portland's Sheraton Hotel which has an outdoor swimming pool and is located next to the nation's largest shopping area, Lloyd Center.

General chairman of the conference is Hollis M. Dole, director of the Oregon Dept. of Geology and Mineral Industries. John R. Anderson, product engineer, Carborundum Co., Vancouver, Wash., is co-chairman.

Plans are forming for the 13th annual Pacific Northwest Metals and Minerals Conference for next April. General chairman Hollis M. Dole, (left) discusses progress with John R. Anderson, co-chairman.

The technical program will cover the fields of gold, physical metallurgy, geology, industrial minerals, iron and steel, mining, petroleum geology, and refractories. Further program details will be announced later.

Other scheduled events will include field trips and a showing of the Peschel Collection and Joy Machinery's collection of mining art at the Portland Art Museum. Mrs. Hollis Dole is in charge of the women's activities.

Other members of the conference committee include Gordon White, chairman of activities and arrangements; Jens Thorjorsen, entertainment; Richard Hanson, responsible for facilities; Robert Hall, working on printing and programs; George Stout, finance, Clifford Glover, concerned with the budget; Joseph Tauscher, assistant for registration; and Ralph S. Mason, in charge of publicity.

AIME Announces Prices For 1960 Publications

The tabulated price information for AIME publications has been announced for 1960. Prices for members and nonmembers are given, but an additional 50¢ will be charged for each book mailed outside of the U. S. to nonmembers.

SME does not plan any special volumes in 1960. However, the third edition of *Industrial Minerals and Rocks*, originally scheduled for 1959, will carry a 1960 copyright date and will be available for $8.40 to members and $12 to nonmembers.

The Society of Petroleum Engineers will issue a volume in two parts entitled *International Oil and Gas Development*. This volume replaces the *Statistics of Oil and Gas Development and Production* and will be published jointly with the International Oil Scouts Assn. Part I covering exploration is to be released in June 1960 and Part II, production, is to be released in October 1960. Prices are not yet available.

Elements of Petroleum Reservoirs, a 300 page book by Norman J. Clark is expected to be published in March 1960. Price to members will be $4.90 and $7 to nonmembers.

Waterflooding, a 200 page booklet of papers previously published in Petroleum Transactions, is to be issued as Petroleum Transactions Reprint Series No. 2, for $2.50, available January 1960. There is no discount to members.

The Metallurgical Society will, as usual, publish the Conference Proceedings for the three Iron and Steel Division Conferences. These are as follows: The Open Hearth Proceedings, The Electric Furnace Proceedings, The Blast Furnace, Coke Oven and Ray Materials Proceedings. These are available to members for $7 and to nonmembers for $10.

Bimonthly Transactions of The Metallurgical Society is available to members for $5 for the first subscription, $20 for any additional subscriptions. Nonmember rate is $20 in North, South, and Central America and $25 elsewhere.

Several other volumes have been planned and will be announced at a later date.

Southwest Metals And Minerals Meet Planned

The Southwest Metals and Minerals Conference, scheduled for next April, will feature guest speaker Joseph L. Gillson, AIME President for 1960. Dr. Gillson has accepted the planning committee's invitation to give the welcoming address on Thursday, April 21. The conference will convene at the Ambassador Hotel in Los Angeles.

A tentative schedule includes many technical sessions, field trips, and social events. A joint session will begin the program with a discussion of requirements for the space age. After the opening luncheon the afternoon promises two symposia, on boron and rock products. Finally that evening the banquet will feature an address by Dr. Hibbs on *Jet Propulsion Laboratories*.

(Continued on page 59)

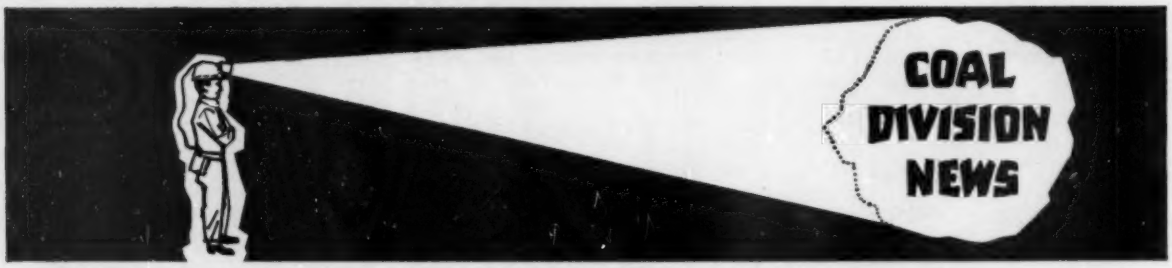
1960 AIME Publications Prices

1959 Bound Transactions Volumes to be Issued in 1960

No.	Technical Area	MEMBERS		NONMEMBERS	
		Pay with Dues	Pay Later	North, South and Central America	Elsewhere
214	Soc. of Mining Eng.	$3.50	$4.90	$ 7.00	$ 7.00
215	The Metallurgical Soc.	5.00	5.00	25.00	30.00
216	Soc. of Petr. Eng.	3.50	4.90	7.00	7.00

1960 Journal Prices

Name	MEMBERS One Journal with Dues		NONMEMBERS	
	Additional Subscriptions		North, South and Central America	Elsewhere
	Other Journal	Same Journal		
Mining Engineering	$4.00	$8.00	$ 8.00	$10.00
Journal of Petroleum Tech.	4.00	8.00	8.00	10.00
Journal of Metals	4.00	8.00	10.00	10.00



Raymond E. Salvati Will Be Honored With The Erskine Ramsay Gold Medal

R. E. SALVATI

Raymond E. Salvati, president of Island Creek Coal Co., president of The American Mining Congress, and one of the nation's eminent leaders in the industry, has been named by AIME to receive the Erskine Ramsay Gold Medal, one of its major awards.

The medal will be presented to Mr. Salvati at the Annual Meeting in New York, February 14 to 18. Its citation reads as follows:

> For his outstanding contributions and achievements in the development and application of modern technology in underground coal mining and in the preparation of bituminous coal, and for his many years of distinguished leadership within the industry.

This medal was established in 1948 through a fund contributed by Erskine Ramsay, former director of the Institute, "to recognize distinguished achievements in coal mining," including both bituminous and anthracite coal.

Mr. Salvati has been a member of AIME since 1936 and is chairman of the Coal Division of SME. Born in Monongah, W. Va., he began his mining career in 1922, after graduation from the University of West Virginia with a degree in mining engineering.

He joined the staff of the Island Creek Coal Co. as trackman and later was made mine foreman and in 1924 was promoted to superintendent over five mines. In 1926 he transferred to the Pond Creek Pocahontas Co., which has since merged with Island Creek, as a superintendent, and two years later was named manager of the company. He was elected a vice president and director of the firm in 1932.

Retaining his status with Pond Creek Pocahontas Co., he returned to Island Creek Coal Co. in 1935. A year later he became general manager, was made vice president in 1940, and a director in 1942. In 1949 Mr. Salvati was elected president of Island Creek Coal Co. and Pond Creek Pocahontas Co. and their subsidiary companies. He was elected vice chairman of Island Creek Coal Sales Co., the sales subsidiary of Island Creek, in 1956.

Mr. Salvati is a member and past president of the board of governors of West Virginia University; a member of the board of trustees of Wheeling College; a director of St. Mary's Hospital in Huntington; and a former director of the National Assn. of Manufacturers. He is a director of American Coal Shipping Inc.; Bituminous Coal Research; National Coal Assoc.; Western Allegheny Railroad Co., and West Virginia Coal Assn. For many years he had been active in civic and business activities and organizations including the Kentucky Mining Inst.; West Virginia Coal Mining Inst.; and West Virginia Society of Professional Engineers. In 1958 Mr. Salvati was selected as one of the eight prominent business and industrial leaders in the U. S. to receive the Horatio Alger Award, and in 1959 he was selected as "West Virginia Son of the Year."

AIME BOARD OF DIRECTORS

Recent actions taken by the Institute Board of Directors.

► By action of the John Fritz Medal Board of Award on May 28, 1959, it was unanimously voted that the American Institute of Chemical Engineers be invited to participate as the fifth administrator of the John Fritz Medal, and that they be requested to appoint representatives and alternates to serve on the Board effective October 1, 1959.

► Approval was voted of the establishment of the Appalachian Petroleum Section of AIME.

► John D. Sullivan was renominated to serve on the Advisory Board of the Office of Critical Tables, National Academy of Sciences.

► C. J. Hunter was appointed representative on the Washington Award Commission to replace M. Tenenbaum whose term expired in May.

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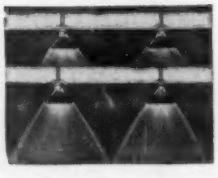

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INDUSTRIAL MINERALS NEWSLETTER

Samuel H. Dolbear Will Receive the 1960 Hal Williams Hardinge Award

Samuel H. Dolbear, eminent consulting mining engineer and geologist, has been named by the AIME to receive the Hal Williams Hardinge Award for 1960. His long career has attained an international scope, particularly in the field of industrial minerals.

Mr. Dolbear will receive the award in recognition of his achievements "for the improvement and increase of mineral knowledge" in many phases of that field. The citation also notes his outstanding services in the founding of the Industrial Minerals Division and his editorial chairmanship of the two first volumes of *Industrial Minerals and Rocks*, an authoritative work.

The award was established by Mrs. Bertha W. Hardinge in memory of her husband, to recognize outstanding contributions to the industrial minerals field. Mr. Hardinge, noted inventor and manufacturer of mining and milling equipment, was himself recipient of a major AIME honor, the James Douglas Gold Medal, for his distinguished work in nonferrous metallurgy.

In a career that stretches back over half a century, Mr. Dolbear has written many technical papers and holds both U. S. and Canadian patents, including about thirty on mineral processes and apparatus. He has been prominent in activities involving trona, potash, magnesite, refractories, asbestos, mica, borax, and others. His operations have included mine examination, plant design, construction and many others.

Sam Dolbear was born in Somerville, Mass. He attended Tufts College and Clark University. After a few years as miner and prospector he entered upon a succession of important posts with several major companies. From 1939 to 1943 he served as president of Wright, Dolbear Co. Inc. of New York. Since 1945 he has headed its successor firm,

Behre Dolbear & Co., mining, geological, and metallurgical consultants.

He has developed this latter firm into what is probably the best known consulting engineering organization in the American mining field. From a small original group the firm has grown to five men who give substantially all of their time to the company's activities, usually in the field, plus seven associates who hold other jobs but who are frequently called on to report on subjects in which they are specialists. Thus the entire geological, mining, and ore processing and reduction fields, including economics, both in America and in foreign countries, are within the specialized scope of the company that Mr. Dolbear heads.

Mr. Dolbear is a former consultant to the U. S. Bureau of Mines and a former member of its advisory committee. He has been chairman of the advisory committee on chromite and a member of the advisory committee on mica, Army and Navy Munitions Board. He also has been a consultant on chromium in the advisory committee to the Council of National Defense. In 1945, Mr. Dolbear was appointed mineral adviser to the Provisional Government of Korea. In 1947 he was technical adviser to the National Resources Committee of China. His work in China and Korea brought him into touch with many of the prominent industrial and governmental leaders of eastern Asia, and he was thoroughly at home in that part of the world before the Communists became dominant.

A man of varied abilities, Sam Dolbear has also lectured at the University of Southern California and is a trustee of Clark University, where he received an honorary Master of Science degree in 1939. He has been an AIME member since 1927, playing an active role in SME and serving as first IndMD chairman.

In private life, Sam, as he is known to his friends, makes his home in an apartment at 1000 Park Avenue, New York City. His devoted wife Inza, to whom he has been married for eighteen years, is an active and universally well liked member of the Woman's Auxiliary of the Institute. Each summer they rent a country home in the area around the northern tip of Fairfield County, Connecticut, where their weekend guests are legion. This private retreat provides unlimited opportunity for Sam's special interest of bird-watching and by the summer's end his list of identified birds is most impressive. The Dolbears are so popular with real estate agents in that area that they have no trouble finding a new summer home or renting the one they had before. Their practice of leaving the house and grounds in better shape than when they found them guarantees their welcome back. This is just one of the many fine qualities that make the Dolbears welcome wherever they go.

G. A. Price Also Honored

For the first time in the 58-year history of the award, the John Fritz Medal has been given to a man with a non-engineering background, for his industrial leadership in the development of atomic power. Gwilym A. Price, chairman of the board of Westinghouse Electric Corp., received this honor in December at the annual meeting of The American Society of Mechanical Engineers in Atlantic City.

AIME, the American Society of Civil Engineers, and the American Institute of Electrical Engineers were represented in the choice of the award winner. Mr. Price formed an atomic power organization within his company which has designed nuclear propulsion plants for the Navy's atomic fleet as well as many peacetime atomic plants.

EDITOR

Address news items to:

R. H. Feierabend, IndMD Secretary-Treasurer, Freeport Sulphur Co., P. O. Box 1520, New Orleans 5, La.

MBD Plans Annual Meeting Session on Magnetizing Roasting of Iron Ore

Magnetizing roasting of iron ore will be the principal theme for one of the eight MBD sessions at the 1960 Annual Meeting. This timely subject highlights a revival of interest in the process both here and abroad. The process has possibilities for treating low-grade ores in which the iron is predominantly in the form of ferric oxides. These ores are known in this country as nonmagnetic taconites, semitaconites, and jaspilites. They make up the largest resources of raw material iron for future utilization.

Flotation and magnetizing roasting-magnetic separation are the leading contenders among processes. While only limited reserves of the coarser-grained ores have been found to be economically amenable to flotation, the roasting process has been practiced in many plants in Europe and the U. S. A.; however, practically all of these roasting operations have been on special types of ores or under economic conditions favorable to this particular process. When the process was tried on ores in which the iron occurs largely as fine-grained varieties of ferric oxides, problems arising from the inefficiency of heat utilization in existing types of gas-solids reactors and in the cleaning step of magnetic separation kept the process out of economic reach. Intensive investigations for the taconite industry, however, have developed new techniques and equipment for magnetic separation which bring the magnetizing roasting process nearer economic reach and have led to the revival of interest in its applications.

Although the conditions for magnetizing roasting have been known and practiced for a long time, relatively recent investigations in the Soviet Union, Great Britain, and the U. S. show that the reduction reaction is not a simple one. The Soviets in particular have done much work on the kinetics of the reaction under lower than normal reaction temperatures and at pressures above atmospheric; they have studied the effects of temperature, pressure, and different reducing gases.

The plans for the pyrolysis and agglomeration session include four papers on magnetizing roasting, a paper by two Soviet engineers on iron ore benefication in the U.S.S.R., including magnetizing roasting, and a paper on pelletizing. Two of the papers on magnetizing roasting will describe pilot plant studies. One by H. W. Wade and N. F. Schulz of the Mines Experiment Station, University of Minnesota, will present data on the operation of a traveling grate of new design on five types of Minnesota low-grade iron ores, including a manganiferrous ore. These tests indicate that the process is technically and economically feasible.

Another paper by J. R. J. Edwards and S. G. Salamy of the Broken Hill Proprietary Co., Ltd., will describe operation of a 1½ ton tandem shaft furnace at Whyalla, Australia, on jaspilite ores from the Middleback Range. The paper will evaluate the effects of temperature, gas composition, and feed size on the production rate and degree of reduction; included will be a discussion of the intercrystalline cracking that results in more complete liberation of magnetite grains. The paper will present data on optimum operating conditions and estimates of consumption of fuel oil, reducing gas, and electric power in a commercial plant.

The other two papers on magnetizing roasting will describe laboratory scale tests. One by W. H. Dailey, Jr., of Surface Combustion Corp. and F. H. Bunge of M. A. Hanna Co. will describe laboratory batch tests with a fixed bed magnetizing roaster, in which precise control was maintained of the gas composition, gas flow, temperature, and reduction time; cracked propane was used for the reducing gas.

A paper by J. E. Astier, P. Emery, and A. Matraski of IRSID in France will explain some of the mechanisms of reduction of hematite on the basis of the Chaudron diagram. It will present data showing the influence of silica on the equilibria among the various iron oxides and metallic iron as developed in tests on pure hematite, low-grade minette ores, and chloritic iron ores.

With the help of Norwood Melcher of U. S. Bureau of Mines, an invitation to have Soviet engineers participate in the session was extended through the Dept. of State to the Scientific and Technical Committee of the Council of Ministers of the U. S. S. R. This resulted in the promise of a paper to be delivered by N. P. Titkov of the Mekhanobr Inst. of Leningrad on *Development of Beneficiation Technology for Hematite Ores.* This paper will present the results of laboratory and pilot plant investigations to develop methods for beneficiating the hematite ores from the Krivoi Rog, Kursk Magnetic Anomaly, Olenogorsk, and other deposits. The paper will describe technological indices for the different beneficiating methods based on the mineralogy of the ores and in particular the iron silicate and quartz contents. Conclusions as to the types of methods most effective for ores of given characteristics will be based on the cost of one ton of pig iron smelted from concentrates made by the various beneficiation methods.

Although magnetizing roasting is an expensive preliminary step, the tests indicated that the pig iron smelted from agglomerated products of the roasting of certain types of ores is less expensive than that from products of these ores made by other beneficiating methods.

The paper on pelletizing by K. E. Merklin and M. H. Childs of Pickands Mather & Co. will describe some of the factors influencing the physical qualities of iron ore pellets as determined by tests on eastern Mesabi Range magnetic taconite concentrates. The paper will discuss effects of coal on the strength of pellets, the effects of surface area of the concentrate particles on green and fired pellet quality, use of bentonite and soda ash as additives, time as temperature, and factors in the formation of thermal cracks in the fired pellets.

The members of the Pyrolysis & Agglomeration Committee responsible for this program are M. E. Volin, Michigan College of Mining and Technology, chairman; Fred H. Bunge, Pickands Mather & Co., co-chairman; Norwood B. Melcher, USBM; Joe B. Rosenbaum, USBM; T. E. Ban, McDowell Co. Inc.; and Gus Bitsianes, University of Minnesota. Harold E. Rowen of McDowell Co. Inc., chairman-elect for the 1961 pyrolysis and agglomeration program, assisted the committee.

Earl Volin, chairman of the committee, is director of the Inst. of Mineral Research at Michigan College of Mining and Technology. He has also worked for the USBM as regional director in Minneapolis and chief of the Branch of Base Metals in Washington, D. C.

Iron Ore Symposium To Convene in Duluth

Lake Superior Iron Ores and the American Economy is the theme of the 21st annual Mining Symposium conducted by the School of Mines and Metallurgy and the Center for Continuation Study at the University of Minnesota.

The meeting will be held in Duluth on Tuesday and Wednesday, January 12 and 13, directly following the AIME Minnesota Section annual meeting on the same general theme. Headquarters for the symposium will be the Hotel Duluth, and sessions are to be held in the Norshore Theater.

Noted participants in the conference include Fred E. Berger, director of the Center for Continuation Study; Dwight C. Brown, assistant director of research, Jones & Laughlin Steel Corp.; and Bay Estes, Jr., vice president, U. S. Steel Corp.

For this 1960 symposium the planning committee considered suggestions from the University based on a questionnaire circulated last year asking top officials of mining companies to choose timely subjects. A program containing practical details as well as discussion of important topics is being developed from these suggestions.

Registration fees are $10, including tuition, payable in advance to the Director, Center For Continuation Study, University of Minnesota, Minneapolis 14, Minn.

B. C. Heezen Will Speak

During the Annual Meeting in February Bruce C. Heezen will address the Industrial Minerals luncheon on the subject of oceanography and submarine topography. Dr. Heezen is the leading authority on this topic at the Lamont Geological Observatory. He will discuss the facets of his work, particularly in the western Atlantic, which will be of future interest to industrial mineral people. The luncheon will be held on February 15.

Southwest Metals

(Continued from page 54)

On Friday there will be a mining session on natural raw materials, and a metals session on beryllium metallurgy. In the afternoon the two sessions will cover industrial minerals and space vehicle structures respectively. Saturday will complete the conference with several field trips.

The conference is being arranged by the Southern California Section in cooperation with the San Francisco and Reno Sections. For further information, write to Room 1234, 523 West 6th St., Los Angeles 14, Calif. John L. Goheen is chairman for publicity.

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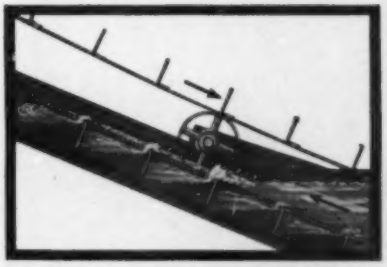

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Unretouched photograph of "Overdrain" action above the belt—water and slimes discharging upwardly.

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Around the Sections

• The **St. Louis Section** went on a field trip to the Iron Mountain mine and mill on October 9, with Robert P. Matson, superintendent, and four other staff members conducting the group through the largest operating iron ore mine in Missouri.

On November 13 the group met at the Hotel York in St. Louis for cocktails and dinner. Guest speaker was Schrade F. Radtke, director of research at American Zinc Inst. Dr. Radtke's topic was *An International Research Program in Lead and Zinc.*

• The 1959 Fall Meeting of the **Pennsylvania-Anthracite Section** was held in Hazleton on October 28 with dinner and a paper presented by Donald Markle, Jr., in collaboration with Michael Waskovich.

• The **Lehigh Valley Section's** fall field trip through the Friendsville Mine of New Jersey Zinc Co. near Bethlehem, Pa., was held on September 19. The 82 members and guests received an orientation lecture covering the geology and the history of mining in the area and were conducted on a tour of the mine and surface plant.

• The fall meeting of the **Black Hills Section** included a tour of the new International Minerals and Chemical Corp. feldspar mill in Custer, S. D. Speakers at the dinner were A. E. Boone and Fred Miller, assistant superintendent and chief chemist respectively.

• The October 17 meeting of the **Montana Section** was held at the Howdy Restaurant in Great Falls with J. J. Dougherty presiding. Fred Strandberg, national director, AIME, reported on the United Engineering Center before the main speaker, Colonel Overing, discussed technical developments in air power. Colonel Overing is Commander of the Air Force Defense Sector at Malmstrom Air Base.

• The **Utah Section** held its October 15 meeting at the Newhouse Hotel in Salt Lake City. Guest speaker Victor L. Stevens, chief mining engineer, Boyles Brothers Drilling Co., gave an interesting presentation of his experiences with operating problems involved in drilling in the New Mexico Ambrosia Lake Region.

• A business meeting for the **Morenci Subsection,** Arizona Section, included the film *The Gooney Bird,* furnished by Dodge Mfg. Co. and Garrett Supply Co. The group met at the Longfellow Inn on October 20.

• The **Washington Section** topic for November 3 was digital computers, with Joseph Daly, chief mathematical statistician, Bureau of Census, as featured speaker.

• A regular dinner meeting of the **Colorado Section** was held on October 15 at the Holland House in Golden. Ladies and students were invited to join the tour of the new professional and recreational facilities of the School of Mines.

• The **Southwest Alaska Section** meeting was held at the State Dept. of Mines Bldg. in Anchorage on September 21. Featured speaker Jerry Herdlich described the mining activities in Alaska.

• A trip to the Hyde Park asbestos operations in September was enjoyed by the **Adirondack Section.** Cocktails, a buffet dinner, discussion of the local asbestos deposits by L. Jourdan and of plant developments by I. E. Mathews filled the program. New officers were elected as follows: Severn Brown, chairman; George Erdman, vice chairman; and Patrick Farrell, secretary-treasurer.

On October 17 the annual Syracuse meeting took place, featuring a tour of the limestone quarry of Solvay Co. and the Syracuse-Holy Cross football game. Dinner that evening was held in the Cavalier Room of the Hotel Syracuse.

• Congratulations from E. H. Robie, secretary of the AIME Fund Raising Committee for the United Engineering Center, were received by the secretary-treasurer of the **Arizona Section** for having exceeded its goal. With many members yet to contribute, the Section may even double its quota.

• An annual joint meeting of the student chapters of **Stanford University** and the **University of California** began with an open house on November 18 at the School of Mineral Sciences, Stanford. After dinner that evening four papers were presented by the following Stanford students: William Clement, John Cole, Ray Dils, and Frances Riley.

• The **San Francisco Section** held its annual Christmas meeting on December 9 at the Engineers Club.

• On November 11 at the Hotel Cortez, the **El Paso Section** welcomed speaker H. Schutz of the Air Arm Div., Westinghouse Electric Corp., for a talk on space engineering.

The Section's Christmas dinner dance was held on December 18, also in El Paso.

• A second meeting of the season for the **Cleveland Section** covered the topic of *Ultrasonic Welding of Aluminum.* Allen S. Russell, chief of process metallurgy, Div. of Alcoa Laboratories, was the speaker and Allen M. Montgomery, Cleveland Works, Alco, was the technical chairman. The meeting took place on October 15 at the Engineering Societies Center.

• December 2 was President's Night for the **New York Section** with cocktails and dinner at the Brass Rail. President Howard C. Pyle addressed the group on the topic of *Our Primary Energy Supply.* The New York Petroleum Section joined in this annual event.

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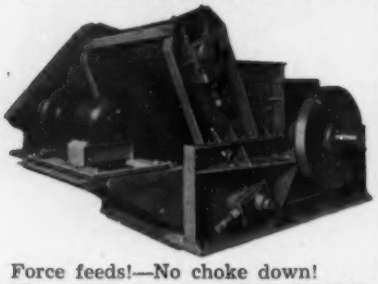

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Personals

Desmond A. Pretorius was senior geologist for Frobisher Ltd. until November when he became senior research fellow at Economic Geology Research Unit of the University of Witwatersrand in Johannesburg, South Africa.

Meredith E. Ostrom has switched from the Illinois to the Wisconsin State Geological Survey, having completed his Ph.D. in geology last June. He advanced from assistant geologist to geologist.

H. G. King graduated in June from the Royal School of Mines in London and is now mining engineer for Iron Ore Co. of Canada.

Roy E. Peterson was a mineral dressing engineer for North Carolina State College until August when he joined Reynolds Metals Co. as metallurgical engineer.

Wing G. Agnew, head of the Bureau of Mines Spokane office of mining research has been appointed mining engineer in the office of the Secretary of the Interior Fred A. Seaton.

William H. Bierschenk, formerly radiohydrologist for General Electric Co. in Richland, Wash., now is geohydrologist for The Frank E. Basil Co. Inc. in Tehran, Iran.

Donald C. Violetta has joined the McDowell Co. Inc. in the Dwight-Lloyd Div. as chief research engineer after six years with Cleveland Cliffs Iron Co. where he was pyrometallurgist.

Kendall Kidder, formerly local sales manager for Canadian Industries Ltd., explosives division, now is blasting supervisor, Carol project, for the Iron Ore Co. of Canada.

J. M. Davey left the Royal School of Mines in London having received B.Sc. and A.R.S.M. degrees and is now a metallurgist with Mount Isa Mines Ltd. in Queensland, Australia.

James R. Perrin, Jr. has left the American Smelting & Refining Co. and joined Rio De Oro Uranium Mines Inc. in Grants, N. M. as an engineer.

Al Robinson recently became employed by the Ingersoll-Rand Co. working in their Minneapolis branch. He formerly worked for the Minnesota State Highway Dept. Another member of the Highway Dept., **John Palmquist,** has been inducted into the U. S. Army for three months.

Annan Cook has accepted the position as resident geologist in charge of the recently acquired Safford Project in Arizona. He was formerly district geologist in charge of the Southwest district for Bear Creek Mining Co., Kennecott's exploration subsidiary.

E. B. HOTCHKISS

R. M. STEWART

Eugene B. Hotchkiss has been named executive vice president of Vitro Minerals Corp. in New York. Mr. Hotchkiss is a director of the firm.

Richard M. Stewart has been appointed director of mining research of The Anaconda Co. He had been assistant research director.

Newton Dana Cook retired from his position as manager of the San Francisco office of Engineering Societies Personnel Service Inc. He has served 34 years as the first and only manager, assisting more than 8000 engineers to find jobs.

James A. Barr, Jr., formerly industrial consutant and director of chemical development for Texas Power & Light Co., has recently been involved in coordinating activities for his new firm of Barr & Associates. His associate, **E. C. Bitzer,** has been assigned to work as metallurgical advisor to the government of Yugoslavia. Mr. Barr, Jr., is active in projects on beryllium, potash, uranium, etc., while his father, **James Barr, Sr.,** is completing phosphate mineral and chemical plant assignments in France and North Africa.

Robert T. Novotny, formerly graduate student at the University of Utah, now is special representative for Gulf Eastern Co., London, working in the oil industry as observer in southern Africa, with headquarters in Salisbury, Southern Rhodesia.

Brinton C. Brown, general foreman for Ideal Cement Co., has transferred from Trident, Mont. to Redwood City, Calif.

Thomas A. Simpson of the U. S. Geological Survey, Ground Water Branch, has transferred to Vienna, Va. He is working on drainage problems in Wilkes Barre, Pa. and ground water hydraulics in the Washington office.

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personals

continued

Roderick W. Adams and **Donald C. Tibbals** have been named sales representatives for the explosives and mining chemicals department, American Cyanamid Co. Mr. Adams will serve customers in California, Nevada, and Utah while Mr. Tibbals will cover the states of Colorado, South Dakota, New Mexico, and Wyoming.

Leonard G. Thomas, partner in Lotridge-Thomas and Assocs., left for Lima, Peru, in November to examine copper properties. After a stop in La Paz, Bolivia, he will proceed to Rio de Janeiro to inspect diamond mining operations in Brazil.

Ronald J. P. Lyon, formerly senior scientist at Kennecott Research Center in Salt Lake City, now is senior geochemist for Stanford Research Inst. in Menlo Park, Calif.

John D. Gardner now is attending Harvard Graduate School of Business Administration after three years as engineer with Phelps Dodge Corp.

L. G. THOMAS

R. J. P. LYON

Thomas G. Ferguson has been elected president and chief executive officer of National Potash Co. He has been in charge of the development and operation of the company's mine and refinery near Carlsbad, N. M., where he will remain.

Appointment of **C. E. Lacy** and **W. D. Reuter** as regional representatives to industries using processing machinery department products has been announced by Allis-Chalmers Mfg. Co. Mr. Lacy is the new Southeast regional representative with headquarters in Atlanta. Mr. Reuter, new Central regional representative, had been in the Columbus district.

Hollis D. Hedberg, vice president, exploration, of Gulf Oil Corp., was elected president of the Geological Society of America at the annual dinner meeting at the Penn Sheraton Hotel, Pittsburgh.

Richard C. Cole, former president of Vitro Uranium Co., has been named vice president in charge of manufacturing of Vitro Chemical Co., a new subsidiary of Vitro Corp. of America. **Paul R. Kruesi,** former general manager of the Rare Earths Div. of Heavy Minerals Co., was named vice president, research and development for the new firm. **Malcolm H. McAllister** will continue as president of Berkshire Chemicals Inc. and has become vice president of Vitro Chemical Co.

Arthur E. Powers has been appointed to the staff of the Knolls Atomic Power Laboratory as a physical metallurgist in the Materials Development Operation. He joined General Electric in 1947.

Solomon Lieb, well known minerals engineer, is on a three-months trip to the Far East, where he will examine tin, gold, and copper occurrences for the Coronado Corp.

M. D. Ayers has been appointed director of engineering at Kennecott Copper Corp. He joined Kennecott in 1956 as assistant to the president and has been engaged in special assignments.

William L. Affelder of Pittsburgh has been elected president of Emerald Coal and Coke Co. and of its fully owned subsidiary, Emerald

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Name .....

Former Company .....

Former Title ..... Length of Time There .....

New Company .....

New Title ..... Date of Change .....

.....

Any recent activity that would be of interest to members:

.....

.....

Land Co. He also continues as vice president of J. H. Hillman & Sons Co.

Robert H. Ashlock, formerly mine superintendent at McFarland & Hullinger, now is general mine foreman at Flat Gap Mine, Treadway, Tenn., for the New Jersey Zinc Co.

Bernard J. O'Neill, Jr., formerly associated with the New Jersey Zinc Co. as resident geologist in charge of exploration for Pennsylvania and the middle Atlantic states, has accepted a position as geologist in the Dept. of Earth Sciences of Stanford Research Inst., Menlo Park, Calif. In this new position Mr. O'Neill will be involved in research programs dealing generally with mineral exploration and development.

M. L. Fitzgerald, who was manager of research and instrumentation divisions for Rhoanglo Mine Services Ltd. in Northern Rhodesia, now is chief metallurgist for Rio Tinto Management Service Pty. Ltd. in Melbourne, Australia.

D. DODD

S. P. WIMPFEN

Dorace Dodd has been appointed assistant manager, tractor division, for The Eimco Corp. He has been senior sales engineer.

Sheldon P. Wimpfen, former vice president of Glen Alden Corp. and official of the U. S. Atomic Energy Commission, has been appointed executive assistant to **Walter L. Rice,** president of Reynolds Mining Corp.

Charles G. Edwards returned to the United States and began working for Gulf Land Enterprises Inc. as operations engineer. He now lives in New Port Richey, Fla.

Donald P. Lambert left his position with Atlas Copco Canada Ltd. in July to accept the job of general manager in charge of operations in Alamos, Sonora, Mexico, with Minas Quintera S. A.

William G. Flangas, mine foreman for Kennecott Copper Corp. for the past six years, now is tunnel superintendent for Reynolds Electric and Engineering Co. He was elected state president of the Nevada Soc. of Professional Engineers.

Thomas R. Fuller of Utah Copper Div., Kennecott Copper Corp., has transferred from Salt Lake City where he was an associate engineer, to Midvale, Utah, where he is mine level foreman at Bingham Pit. He has been learning the details of milling, smelting, and refining Utah copper ores.

Harmon E. Keyes has returned from Nicaragua where he has been engaged in supervising the design, construction and operation of an autoxidation acid plant for La Luz and Rosita Mines Ltd. at Suina. Mr. Keyes is maintaining his consulting office at 508 E. Culver St., Phoenix, Ariz.

James B. Copeland, formerly of Glen Ellyn, Ill. and commanding officer in the U. S. Army, now is shift boss trainee with Bunker Hill Co. in Kellogg, Idaho.

John B. Campbell, formerly metallurgical chemist for Manganese Inc., now is research chemist for Howe Sound Co., the parent company. He will continue to be in Henderson, Nev.

William T. Hill, who was general superintendent of Putnam & Assocs., now is geologist with the New Jersey Zinc Co. in the exploration department in Jefferson City, Tenn.

Alan Keenan of Ingersoll Rand Co. was an engineer in Dover, N. J., and

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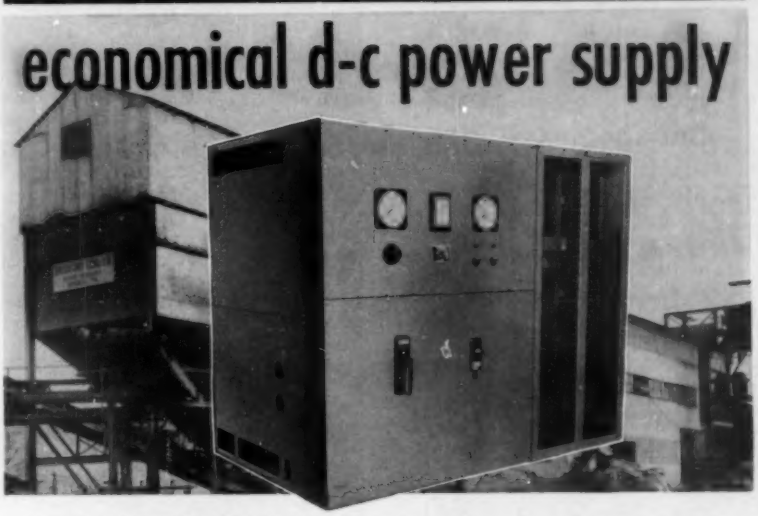

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Alaska.....Contact Salt Lake City Office

personals

continued

now is salesman in Scranton, Pa.

Joseph H. V. Alexis, who has been an engineer officer in the U. S. Navy, now is employed by Ingersoll-Rand as an engineer in New York.

John A. Johnson, who has been with the U. S. Bureau of Mines since 1936 as chief of the Div. of Safety in Washington, D. C., retired in December and moved to Tucson, Ariz.

Brian Kerns spent over two years at Hudson Bay Mining & Smelting Co. Ltd. in Flin Flon, Manitoba as mining engineer for equipment and research, and now is mine planning engineer for Giant Yellowknife Gold Mines Ltd. in the Canadian Northwest Territories.

Albert P. E. Hopkins, of Hopkins Mining Consultants Ltd. in Toronto, has been appointed consulting engineer for Queensland Explorations Ltd. doing diamond drilling in Red Lake and Sudbury areas in Ontario, drilling for trap rock quarry on an island in Lake Huron near Spanish, Ont., and explorations for lode diamonds near Cochrane, Ont. for International Copper & Cobalt Co. Ltd.

Ted D. Haley, engineer for Nashville Coal Inc. for the past four years, has accepted the post of superintendent for Lone Star Steel Co. in Bokoshe, Okla.

Robert C. Cockrell is now field engineer with The Eimco Corp. in Birmingham.

Charles E. McGraw resigned as vice president and general manager of Marcona Mining Co. in Lima, Peru, and became special vice president of Utah Construction and Mining Co. as assistant manager of the construction division.

D. F. Towse has been transferred from Brazil where he managed an exploration program in the Amazon basin, to the Oakland, Calif., office of Kaiser Aluminum and Chemical Corp. He retains his position as project geologist.

G. C. AMSTUTZ

R. C. MEISSNER

G. C. Amstutz, associate professor of economic geology and geochemistry at Missouri School of Mines, has returned from his second summer tour to Europe where he lectured on topics of ore genesis and exploration.

Robert C. Meissner has been named president of Meissner Engineers, Inc. of Chicago. Previously he was executive vice president of the firm and administrative officer for all projects in consulting and design.

John J. McGlone, vice president of The Wellman Engineering Co., has been named Chicago district manager where he will represent the line of the McDowell-Wellman family. Formerly he was general manager of the Williams bucket division of Wellman.

John W. Hanley, second from left, is honored with a gold pin commemorating a quarter century of service with Cerro de Pasco Corp. where he is chief metallurgical engineer. From the left the well-wishers are A. R. Merz; F. R. Russell, chairman of the board; R. P. Koenig, president; and A. H. Engelhardt, vice president in South America.

The appointment of **Evan Hall** as assistant plant manager for Calaveras Cement Co. at the San Andreas, Calif. plant has been announced. He had been mill superintendent, and has been succeeded by **David Cosgrave. Joseph Kiley** was promoted to personnel and safety supervisor; **Joseph Vetter** became office manager; and **Duke Kathan** is now assistant mill superintendent.

John F. Gates has been appointed regional director, Africa, for Cyanamid International, a division of American Cyanamid Co. Previously he was regional director for Central and Southern Africa. His headquarters are now in Rome.

The New Jersey Zinc Co. announced the election on **Lawrence S. Pricher** as vice president. He had been vice president, finance, of the Foster-Wheeler Corp.

Herbert E. Steinmann, Jr., has been appointed chief mining engineer at the Vesta-Shannopin Coal Div. of Jones & Laughlin Steel Corp. He had been assistant chief mining engineer.

Harold H. West and **George M. Meisel** have been appointed design engineers at Western Mining Divisions engineering department of Kennecott Copper Corp.

Joseph L. Fisher has been elected president and executive director of Resources for the Future Inc. He succeeds Reuben G. Gustavson who retired.

T. M. Cromwell has been appointed process superintendent in the production department at the United States Borax & Chemical Corp. refinery at Boron, Calif.

Henry R. Linden and **Henry A. Dirksen** of the Inst. of Gas Technology have been named recipients of the Bituminous Coal Research Inc. Award for the best paper pertaining to coal and derived products presented at the 1959 Fall Meeting of the Div. of Gas and Fuel Chemistry, American Chemical Society.

P. L. DuBrow, S. H. Shapiro, and **R. E. Baarson** have been appointed assistant research directors of the Armour Industrial Chemical Co. **Charles L. Ray** has been appointed flotation section head succeeding Mr. Baarson and **Jack N. Dybalski** was named general applications section head in place of Mr. DuBrow. **Don Berenschot** is now section head of new products applications.

Willard Jillson, former state geologist of Kentucky, was honored at the 50th anniversary convention of Pi Delta Epsilon, national honorary journalism society. One of the founders of the organization in 1909, Dr. Jillson received the Medal of Merit.

W. H. SCOTT

D. L. CALDWELL

William H. Scott has been appointed assistant district manager in New York for Eastern Gas and Fuel Associates Coal Div. He has been district sales manager in New York for the Berwind-White Coal Mining Co.

David L. Caldwell, formerly minerals officer for the U. S. Bureau of Indian Affairs, now is a tax law specialist for the Internal Revenue Service.

For the best annual report of the mining industry, The Anaconda Co. was presented a Bronze Oscar by FINANCIAL WORLD. Shown here is Edward S. McGlone, left, executive vice president of Anaconda, accepting the award from R. J. Anderson, publisher.

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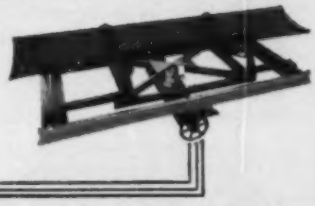

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Obituaries

Edward L. Young

An Appreciation By
Michael H. Kuryla

Edward L. Young (Member 1918) died May 7, 1959, in Santa Ana, Calif. Because of his character, personality, and accomplishments as a mining executive, I feel sure that my deep sense of loss is shared by many former associates and AIME members such as C. F. Moore, Fred Searls, Jr., A. B. Marquand, H. I. Altshuler, R. N. Hunt, C. B. E. Douglas, and C. L. Thornburg.

I am taking the liberty of offering some notes on Ed Young's later career. (Ed. Note: Brief details of Mr. Young's early career appeared in MINING ENGINEERING, October 1959, page 1066.) Following work at California gold properties he joined the United Smelting Refining and Mining Co. subsidiary at the Sunnyside, Colo. property (a pioneer in all-selective flotation of lead-zinc-iron ore). Here he was mine superintendent in 1919 and manager from 1920 to 1924.

Subsequently his career with U. S. Smelting was at Real del Monte y Pachuca, Mexico, for many years the world's largest silver mines. At Real del Monte he was assistant manager in 1925, manager from 1930 to 1937, and consulting mining engineer from 1938 to 1946.

Ed Young had unusually broad knowledge of underground mining. Fred Searls and R. N. Hunt often expressed high regard for his sound geology. Quite a number of later mining executives gratefully acknowledged the benefits of training under Ed Young. I do not hesitate to say that he was virtually my "right hand" during half my 33 years with U. S. Smelting.

Clifton T. Barker (Member 1922), native of Minnesota, died on June 8, 1959, at his home in Knoxville, Tenn. He had been educated at the University of Minnesota, graduating in 1922, and his first job was with the Shenango Valley Improvement Co. in Pennsylvania. In 1924 he joined the Corps of Engineers for the development of navigation, flood control, and hydroelectric power in the Tennessee River Basin. He was later one of the first TVA employes, as chief of the River Transportation Div. and continued, until his death, as a full-time waterway transportation specialist.

Richard L. Bowditch (Member 1925), chairman of the board of C. H. Sprague & Son Co., passed away on July 31, 1959. He was also president of Sprague Steamship Co. and C. H. Sprague & Son (Canada) Ltd. Born in Milton, Mass., he attended Massachusetts Inst. of Technology and spent an active life in the coal and shipping industries.

Blandford C. Burgess (Member 1920) passed away on Aug. 10, 1959. Born in San Francisco, he attended the University of California. He worked for the California Highway Commission and Western Canal Co. and in 1918 became chief engineer for Iron Gap Copper Co. in Arizona. He later was branch manager of mining production for United Feldspar Corp. and secretary, manager of Carolina Pyrophyllite Co. in Spruce Pine, N.C. In his later years he became a consultant located in Monticello, Ga., and travelled to Africa and France.

Necrology

Date Elected	Name	Date of Death
1958	Keith N. Burgess	Mar. 6, 1959
1904	Louis S. Cates	Oct. 29, 1959
	Honorary Member	
1928	Irving B. Crosby	Sept. 18, 1959
1916	Alexander Deussen	Sept. 5, 1959
1947	Carl S. Elayer	Oct. 17, 1959
1917	Albert W. Hahn	October 1959
1937	K. E. Hambien	Unknown
1915	Perry G. Harrison	Nov. 11, 1959
1919	Carlton D. Hulin	Oct. 8, 1959
1939	T. V. Lord	Oct. 13, 1959
1911	R. F. Manahan	June 30, 1959
1936	Walter L. Penick	Nov. 11, 1959
1897	Charles A. Weck	Nov. 2, 1959
	Legion of Honor	
1951	Hedley N. Whitford	Oct. 13, 1959

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The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

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Sidney D. Day, London, England
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Garth A. Duell, Portland, Ore.
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James R. Stewart, Lynch, Ky.
William F. Taylor, San Francisco
Stewart W. Tresouthick, New York

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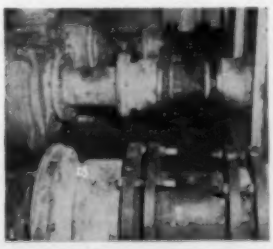

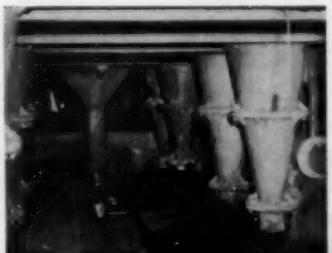

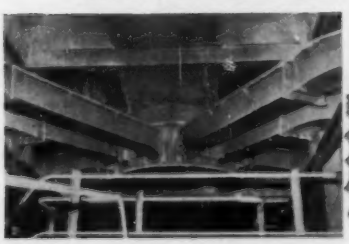

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1. View of Port pump well.
2. View of Linatex-lined distribution box and chutes.
3. View of cyclone underflow and discharge hopper.

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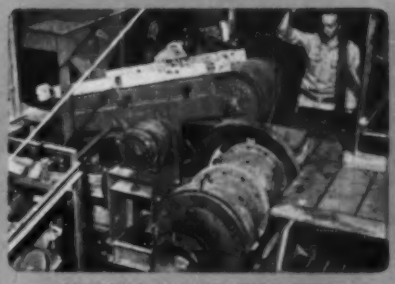

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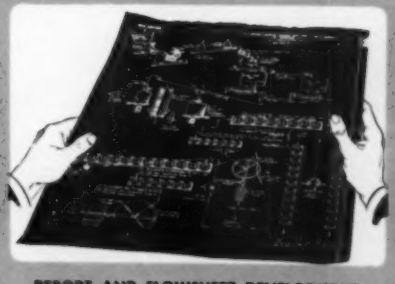

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